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ASA

American Standard

Acoustical Terminology

Z24.1-1951

CORRECTION SHEET

In subsections 1.325 and 1.365, the following changes should be made:

1.325 Sound Pressure Level — Page 11

Change Note 2 to read:

Note 2: It is to be noted that in many sound fields the sound pressure ratios are not the square roots of the corresponding power ratios and hence cannot be expressed in decibels in the strict sense; however, it is common practice to extend the use of the decibel to these cases. (See 1.280 and 1.285)

1.365 Velocity Level — Page 12

Change Note to read:

Note: It is to be noted that in many sound fields the particle velocity ratios are not the square roots of corresponding power ratios and hence cannot be expressed in decibels in the strict sense; however, it is common practice to extend the use of the decibel to these cases. (See 1.280 and 1.285)

July 31, 1952

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American Standard

Acoustical Terminology

Sponsor
ACOUSTICAL SOCIETY OF AMERICA
In Cooperation With
THE INSTITUTE OF RADIO ENGINEERS, INC

Approved July 31, 1951

AMERICAN STANDARDS ASSOCIATION
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Foreword

(This Foreword is not a part of the American Standard Acoustical Terminology, Z24.1-1951.)

This standard comprises a part of a group of definitions, standards, and specifications for use in acoustical work.

In May, 1932, the American Standards Association initiated a standardization project on Acoustical Measurements and Terminology under the sponsorship of the Acoustical Society of America. The scope of this project is as follows:

> Preparation of standards of terminology, units, scales, and methods of measurement in the fields of acoustics and mechanical vibration.

A committee was organized to take charge of this work, and this committee, in turn, appointed subcommittees to carry out the program. Among the standards issued was one on Acoustical Terminology, Z24.1-1942. Following the Second World War, with its impact on acoustical work, both the American Standards Association and the Institute of Radio Engineers decided to revise their standards on acoustical and electroacoustical terminology. The American Institute of Electrical Engineers, as sponsor of Sectional Committee C42, also undertook a revision of American Standard Definitions of Electrical Terms.

After several years of independent effort the ASA and IRE committees were combined. This larger group worked in close cooperation with various subcommittees of C42 concerned with the Definitions of Electrical Terms. When the work of the combined committee was completed the IRE, on the recommendation of its Electroacoustics Committee, published a major part as "Standards on Electroacoustics, Definitions of Terms, 1951."* All terms therein are included in American Standard Acoustical Terminology, but not all terms in this standard are included in the IRE publication.

Sectional Committee Z24, responsible for this and other acoustical standards, has at this time the following personnel:

Leo L. Beranek, *Chairman* †K. C. Morrical, *Vice-Chairman*

J. W. McNair, *Secretary*

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Proceedings, Institute of Radio Engineers, 509, **39**,1951. Reprints of standard known as 51 IRE 6.51.

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Contents

American Standard Acoustical Terminology

SECTION 1

General

1.005 Sound

(a) Sound is an alteration in pressure, stress, particle displacement, particle velocity, etc, which is propagated in an elastic material, or the superposition of such propagated alterations.

(b) Sound is also auditory sensation which is usually evoked by the alterations described above.

NOTE: In case of possible confusion, the term "sound wave" or "elastic wave" may be used for concept *(a)*, and the term "sound sensation" for concept *(b)*.

1.010 Acoustics. Acoustics is the science of sound including its production, transmission, and effects.

1.015 Acoustic.* The word "acoustic," when used as a qualifying term, means containing, producing, arising from, actuated by, or carrying sound, or designed to carry sound and capable of doing so.

EXAMPLES: Acoustic horn, transducer, energy, wave, impedance.

1.020 Acoustical.* The word "acoustical," when used as a qualifying term, means related to, pertaining to, or associated with sound, but not having its properties or characteristics.

EXAMPLES: Acoustical engineer, school, glossary, unit.

1.025 Wave. A wave is a disturbance which is propagated in a medium in such a manner that at any point in the medium the displacement is a function of the time, while at any instant the displacement at a point is a function of the position of the point.

Any physical quantity which has the same relationship to some independent variable (usually time) that a propagated disturbance has, at a particular instant, with respect to space, may be called a wave.

NOTE: In this definition, displacement is used as a general term, indicating not only mechanical displacement, but also electric displacement, etc.

1.030 Noise. Noise is any undesired sound. By extension, noise is any unwanted disturbance within a useful frequency band, such as undesired electric waves in any transmission channel or device.

1.035 Distortion. Distortion is a change in wave form. Noise and certain desired changes in wave form, such as those resulting from modulation or detection, are not usually classed as distortion.

*This usage of "acoustic" and "acoustical" as modifiers agrees with the commonly accepted usage of "electric" and "electrical." In the science of mechanics, however, the term "mechanical" is the only modifier in common use.

1.040 Oscillation (Vibration). Oscillation is the variation, usually with time, of the magnitude of a quantity with respect to a specified reference when the magnitude is alternately greater and smaller than the reference.

1.045 Periodic Quantity. A periodic quantity is an oscillating quantity the values of which recur for equal increments of the independent variable. If a periodic quantity, y, is a function of x, then y has the property that

$$y = f(x) = f(x + k)$$

where k, a constant, is a period of y.

The smallest positive value of k is the primitive period of y, generally called simply the period of y.

NOTE: In general, a periodic function can be expanded into a series of the form

$$y = f(x) = A_0 + A_1 \sin(\omega x + a_1) + A_2 \sin(2\omega x + a_2) + \ldots,$$

where

ω, a positive constant, equals 2π divided by the period k, and the A's and a's are constants which may be positive, negative, or zero.

1.050 Period (Primitive Period). The period of a periodic quantity is the smallest value of the increment of the independent variable for which the function repeats itself.

1.055 Cycle. A cycle is the complete sequence of values of a periodic quantity which occur during a period.

1.060 Frequency of a Periodic Quantity. The frequency of a periodic quantity, in which time is the independent variable, is the number of periods occurring in unit time. If a periodic quantity, y, is a function of the time, t, such that

$$y = f(t) = A_0 + A_1 \sin(\omega t + a_1) + A_2 \sin(2\omega t + a_2) + \ldots,$$

then the frequency is $\omega/2\pi$.

NOTE 1: Unless otherwise specified, the unit is the cycle per second.

NOTE 2: It is recommended that the following terms be discontinued: double vibrations, dv, periods per second, pps, and hertz, all of which are equivalent to cycles per second, and vibrations per second, vs, which has sometimes been used as the equivalent of half-cycles per second.

1.065 Amplitude of a Generalized Sinusoidal Quantity. The amplitude of a generalized sinusoidal

quantity for any value of the independent variable is the value of the modifying function for that particular value of the independent variable. If

$$y = f_0(x) \sin(\omega x + \alpha)$$

the amplitude of y for $x = x_1$ is $f_0(x_1)$.

1.070 Amplitude of a Simple Sinusoidal Quantity. The amplitude of a simple sinusoidal quantity is the largest value that the quantity attains. If

$$y = A \sin(\omega x + \alpha)$$

A is the amplitude.

1.075 Peak-to-Peak Amplitude (Double Amplitude). The peak-to-peak amplitude of an oscillating quantity is the difference between extremes of the quantity.

1.080 Phase of a Periodic Quantity. The phase of a periodic quantity, for a particular value of the independent variable, is the fractional part of a period through which the independent variable has advanced, measured from an arbitrary origin.

NOTE: In the case of a simple sinusoidal quantity, the origin is usually taken as the last previous passage through zero from the negative to positive direction. The origin is generally so chosen that the fraction is less than unity.

1.085 Wave Front

(a) The wave front of a progressive wave in space is a continuous surface which is a locus of points having the same phase at a given instant.

(b) The wave front of a progressive surface wave is a continuous line which is a locus of points having the same phase at a given instant.

1.090 Wavelength. The wavelength of a periodic wave in an isotropic medium is the perpendicular distance between two wave fronts in which the displacements have a difference in phase of one complete period.

1.095 Fundamental Frequency. The fundamental frequency of a periodic quantity is the frequency of a sinusoidal quantity which has the same period as the periodic quantity.

1.100 Basic Frequency. The basic frequency of an oscillatory quantity having sinusoidal components with different frequencies is the frequency of the component considered to be the most important.

NOTE: In a driven system, the basic frequency would in general be the driving frequency, and in a periodic oscillatory system, it would be the fundamental frequency.

1.105 Harmonic. A harmonic is a sinusoidal quantity having a frequency which is an integral multiple of the fundamental frequency of a periodic quantity to which it is related. For example, a wave, the frequency of which is twice the fundamental frequency, is called the second harmonic.

NOTE: This definition is in physical terms. For the definition in musical terms see 6.035.

1.110 Subharmonic. A subharmonic is a sinusoidal quantity having a frequency which is an integral submultiple of the fundamental frequency of a periodic quantity to which it is related. For example, a wave, the frequency of which is half the fundamental frequency of another wave, is called the second subharmonic of that wave.

1.115 Spectrum. The spectrum of a wave is the distribution in frequency of the magnitudes (and sometimes phases) of the components of the wave. Spectrum also is used to signify a continuous range of frequencies, usually wide in extent, within which waves have some specified common characteristic, *e.g.*, audio frequency spectrum, radio frequency spectrum, etc.

1.120 Line Spectrum. A line spectrum is the spectrum of a wave the components of which are confined to a number of discrete frequencies.

1.125 Continuous Spectrum. A continuous spectrum is the spectrum of a wave the components of which are continuously distributed over a frequency region.

1.130 Compressional Wave. A compressional wave is a wave in an elastic medium which causes an element of the medium to change its volume without undergoing rotation.

NOTE 1: Mathematically, a compressional wave is one whose velocity field has zero curl.

NOTE 2: A compressional plane wave is a longitudinal wave.

1.135 Longitudinal Wave. A longitudinal wave is a wave in which the direction of displacement at each point of the medium is normal to the wave front.

1.140 Shear Wave (Rotational Wave). A shear wave is a wave in an elastic medium which causes an element of the medium to change its shape without a change of volume.

NOTE 1: Mathematically, a shear wave is one whose velocity field has zero divergence.

NOTE 2: A shear plane wave in an isotropic medium is a transverse wave.

1.145 Transverse Wave. A transverse wave is a wave in which the direction of displacement at each point of the medium is parallel to the wave front.

1.150 Plane Wave. A plane wave is a wave in which the wave fronts are everywhere parallel planes normal to the direction of propagation.

1.155 Spherical Wave. A spherical wave is a wave in which the wave fronts are concentric spheres.

1.160 Cylindrical Wave. A cylindrical wave is a wave in which the wave fronts are coaxial cylinders.

1.165 Plane Polarized Sound Wave (Linearly Polarized Sound Wave). At a point in an elastic medium, a plane polarized sound wave is a transverse wave in which the displacements at all times lie in a fixed plane which is parallel to the direction of propagation.

NOTE: The above definition is equivalent to stating that, in a plane polarized sound wave, the displacement vector at any point lies in a fixed straight line passing through the point.

1.170 Elliptically Polarized Sound Wave. An elliptically polarized sound wave is a transverse wave in an elastic medium in which the displacement vector at any point rotates about the point and has a magnitude which varies as the radius vector of an ellipse.

NOTE: An elliptically polarized wave is equivalent to two superimposed plane polarized waves of simple sinusoidal form in which the displacements lie in perpendicular planes and are in quadrature.

1.175 Circularly Polarized Sound Wave. A circularly polarized sound wave is an elliptically polarized sound wave in which the displacement vector at any point rotates about the point with constant angular velocity and has a constant magnitude.

A circularly polarized wave is equivalent to two superposed plane polarized waves of sinusoidal form in which the displacements have the same amplitude, lie in perpendicular planes, and are in quadrature.

1.180 Sound Field. A sound field is a region containing sound waves.

1.185 Free Field. A free field is a field (wave or potential) in a homogeneous, isotropic medium free from boundaries. In practice it is a field in which the effects of the boundaries are negligible over the region of interest.

NOTE: The actual pressure impinging on an object (*e.g.*, electroacoustic transducer) placed in an otherwise free sound field will differ from the pressure which would exist at that point with the object removed, unless the acoustic impedance of the object matches the acoustic impedance of the medium.

1.190 Free Progressive Wave (Free Wave). A free progressive wave is a wave in a medium free from boundary effects. A free wave in a steady state can only be approximated in practice.

1.195 Diffuse Sound. Diffuse sound in a given region is sound which has uniform energy density and is such that all directions of energy flux at all parts of the region are equally probable.

1.200 Audio Frequency. An audio frequency is any frequency corresponding to a normally audible sound wave.

NOTE 1: Audio frequencies range roughly from 15 to 20,000 cycles per second.

NOTE 2: The word "audio" may be used as a modifier to indicate a device or system intended to operate at audio frequencies, *e.g.*, "audio amplifier."

1.205 Infrasonic Frequency (Subsonic Frequency*). An infrasonic frequency is a frequency lying below the audio frequency range.

NOTE: The word "infrasonic" may be used as a modifier to indicate a device or system intended to operate at infrasonic frequencies.

1.210 Ultrasonic Frequency (Supersonic Frequency†). An ultrasonic frequency is a frequency lying above the audio frequency range. The term is commonly applied to elastic waves propagated in gases, liquids, or solids.

NOTE: The word "ultrasonic" may be used as a modifier to indicate a device or system intended to operate at ultrasonic frequencies.

1.215 Beats. Beats are periodic variations that result from the superposition of waves having different frequencies.

1.220 Wave Interference. Wave interference is the phenomenon which results when waves of the same or nearly the same frequency are superposed and is characterized by a spatial or temporal distribution of amplitude of some specified characteristic differing from that of the individual superposed waves.

1.225 Standing Waves. Standing waves are periodic waves having a fixed distribution in space which is the result of interference of progressive waves of the same frequency and kind. Such waves are characterized by the existence of nodes or partial nodes and antinodes that are fixed in space.

1.230 Stationary Waves. Stationary waves are standing waves in which the energy flux is zero at all points.

NOTE: Stationary waves can only be approximated in practice.

1.235 Nodes. Nodes are the points, lines, or surfaces in a standing wave system where some characteristic of the wave field has essentially zero amplitude.

NOTE: The appropriate modifier should be used with the word "node" to signify the type that is intended (pressure node, velocity node, etc).

1.240 Antinodes (Loops). Antinodes are the points, lines, or surfaces in a standing wave system

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*Deprecated

†Obsolete. See 4.010.

where some characteristic of the wave field has maximum amplitude.

NOTE: The appropriate modifier should be used with the word "antinode" to signify the type that is intended (pressure antinode, velocity antinode, etc).

1.245 Partial Nodes. Partial nodes are the points, lines, or surfaces in a standing wave system where some characteristic of the wave field has a minimum amplitude differing from zero.

NOTE: The appropriate modifier should be used with the words "partial node" to signify the type that is intended (pressure partial node, velocity partial node, etc).

1.250 Modulation. Modulation is the process or the result of the process whereby some characteristic of one wave is varied in accordance with some characteristic of another wave.

1.255 Echo. An echo is a wave which has been reflected or otherwise returned with sufficient magnitude and delay to be perceived in some manner as a wave distinct from that directly transmitted.

1.260 Flutter Echo. A flutter echo is a rapid succession of reflected pulses resulting from a single initial pulse.

1.265 Musical Echo. A musical echo is a flutter echo that is periodic and has a flutter the frequency of which is in the audible range.

1.270 Rate of Decay. The rate of decay is the time rate at which the sound pressure level (or velocity level, or sound-energy density level) is decreasing at a given point and at a given time. The practical unit is the decibel per second.

1.275 Reverberation. Reverberation is the persistence of sound at a given point after direct reception from the source has stopped.

NOTE: This may be due (*a*) (as in the case of rooms) to repeated reflections from a small number of boundaries or to the free decay of the normal modes of vibration that were excited by the sound source, (*b*) (as in the case of underwater sound in the ocean) to scattering from a large number of inhomogeneities in the medium or reflection from bounding surfaces.

1.280 Bel. The bel is a dimensionless unit for expressing the ratio of two values of power, the number of bels being the logarithm to the base 10 of the power ratio.

NOTE: With P_1 and P_2 designating two amounts of power and N the number of bels corresponding to the ratio P_1/P_2

$$N = \log_{10} (P_1/P_2)$$

1.285 Decibel (db). The decibel is one-tenth of a bel. The abbreviation "db" is commonly used for the term decibel.

NOTE: With P_1 and P_2 designating two amounts of power and n the number of decibels corresponding to their ratio

$$n = 10 \log_{10} (P_1/P_2)$$

When the conditions are such that scalar ratios of currents or of voltages (or analogous quantities in other fields such as pressures, amplitudes, particle velocities in sound) are the square roots of the corresponding power ratios, the number of decibels by which the corresponding powers differ is expressed by the following formulae:

$$n = 20 \log_{10} (I_1/I_2)$$

$$n = 20 \log_{10} (V_1/V_2)$$

where I_1/I_2 and V_1/V_2 are the given current and voltage ratios, respectively.

By extension, these relations between numbers of decibels and scalar ratios of currents or voltages are sometimes applied where these ratios are not the square roots of the corresponding power ratios; to avoid confusion, such usage should be accompanied by a specific statement of this application.

1.290 Neper (Napier*). The neper is a unit used to express the scalar ratio of two currents or two voltages, the number of nepers being the natural logarithm of such ratio.

NOTE 1: With I_1 and I_2 designating the scalar value of two currents, and n the number of nepers denoting their scalar ratio

$$n = \log_e (I_1/I_2)$$

When the conditions are such that the power ratio is the square of the corresponding current or voltage ratio, the number of nepers by which the corresponding voltages or currents differ may be expressed by the following formula:

$$n = 1/2 \log_e (P_1/P_2)$$

where P_1/P_2 is the given power ratio.

By extension, this relation between number of nepers and power ratio is sometimes applied where this ratio is not the square of the corresponding current or voltage ratio; to avoid confusion, such usage should be accompanied by a specific statement of this application.

NOTE 2: One neper is equal to 8.686 db.

NOTE 3: The neper is used in mechanics and acoustics by extending the above definition to include all scalar ratios of like quantities which are analogous to current or voltage.

1.295 Static Pressure (Hydrostatic Pressure). The static pressure at a point in a medium is the pressure that would exist at that point with no sound waves present. In acoustics, the commonly used unit is the microbar.

1.300 Microbar, Dyne Per Square Centimeter (Barye*) (Bar*). A microbar is a unit of pressure commonly used in acoustics. One microbar is equal to 1 dyne per square centimeter.

NOTE: The term "bar" properly denotes a pressure of 10^6 dynes per square centimeter. Unfortunately, in acoustics the bar was used to mean 1 dyne per square centimeter. It is recommended, therefore, in respect to sound pressures that the less ambiguous terms "microbar" or "dyne per square centimeter" be used.

1.305 Instantaneous Sound Pressure. The instantaneous sound pressure at a point is the total instantaneous pressure at that point minus the static pressure at that point. The commonly used unit is the microbar.

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*Deprecated

1.310 Maximum Sound Pressure. The maximum sound pressure for any given cycle of a periodic wave is the maximum absolute value of the instantaneous sound pressure occurring during that cycle. The commonly used unit is the microbar.

NOTE: In the case of a sinusoidal sound wave this maximum sound pressure is also called the pressure amplitude.

1.315 Peak Sound Pressure. The peak sound pressure for any specified time interval is the maximum absolute value of the instantaneous sound pressure in that interval. The commonly used unit is the microbar.

NOTE: In the case of a periodic wave, if the time interval considered is a complete period, the peak sound pressure becomes identical with the maximum sound pressure.

1.320 Effective Sound Pressure (Root-Mean-Square Sound Pressure). The effective sound pressure at a point is the root-mean-square value of the instantaneous sound pressures, over a time interval at the point under consideration. In the case of periodic sound pressures, the interval must be an integral number of periods or an interval long compared to a period. In the case of nonperiodic sound pressures, the interval should be long enough to make the value obtained essentially independent of small changes in the length of the interval.

NOTE: The term "effective sound pressure" is frequently shortened to "sound pressure."

1.325 Sound Pressure Level.* The sound pressure level, in decibels, of a sound is 20 times the logarithm to the base 10 of the ratio of the pressure of this sound to the reference pressure. The reference pressure shall be explicitly stated.

NOTE 1: The following reference pressures are in common use:

(*a*) 2×10^{-4} microbar
(*b*) 1 microbar

Reference pressure (*a*) has been in general use for measurements dealing with hearing and sound-level measurements in air and liquids, while (*b*) has gained widespread use for calibrations and many types of sound-level measurements in liquids.

NOTE 2: It is to be noted that in many sound fields the sound pressure ratios are not proportional to the square root of corresponding power ratios and hence cannot be expressed in decibels in the strict sense; however, it is common practice to extend the use of the decibel to these cases. (See 1.280 and 1.285.)

1.330 Band Pressure Level. The band pressure level of a sound for a specified frequency band is the effective sound pressure level for the sound energy contained within the band. The width of the band and the reference pressure must be specified.

NOTE: When measuring thermal noise, the standard deviation of the sound pressure readings will not exceed about 10 percent if the product of the band width in cycles per second and the integration time in seconds exceeds 20.

1.335 Octave-Band Pressure Level (Octave Pressure Level). The octave-band pressure level of a sound is the band pressure level for a frequency band corresponding to a specified octave.

NOTE: The location of the octave-band pressure level on a frequency scale is usually specified as the geometric mean of the upper and lower frequencies of the octave.

1.340 Pressure Spectrum Level. The pressure spectrum level of a sound at a specified frequency is the effective sound pressure level for the sound energy contained within a band 1 cycle per second wide, centered at the specified frequency. Ordinarily this has significance only for sound having a continuous distribution of energy within the frequency range under consideration. The reference pressure should be explicitly stated. (See 1.325.)

NOTE: Since in practice it is necessary to employ filters having an effective band width greater than 1 cycle per second, the pressure spectrum level is in general a computed quantity. For a sound having a uniform distribution of energy, the computation can be made as follows: Let L_{ps} be the desired pressure spectrum level, p be the effective pressure measured through the filter system, p_0 be reference sound pressure, Δf be the effective band width of the filter system (see 3.220), and $\Delta_0 f$ be the reference band width (1 cycle per second), then

$$L_{ps} = 10 \log_{10} \left[\frac{p^2/\Delta f}{p_0^2/\Delta_0 f} \right]$$

For computational purposes, if L_p is the band pressure level observed through the filter, the above relation reduces to

$$L_{ps} = L_p - 10 \log_{10} \frac{\Delta f}{\Delta_0 f}$$

1.345 Velocity. The velocity of a point is the time rate of change of a position vector of that point with respect to an inertial frame.

NOTE: In most cases the approximation is made that axes fixed to the earth constitute an inertial frame.

1.350 Relative Velocity. The relative velocity of a point with respect to a reference frame is the time rate of change of a position vector of that point with respect to the reference frame.

1.355 Acceleration. The acceleration of a point is the time rate of change of the velocity of the point.

1.360 Particle Velocity. In a sound wave the particle velocity is the velocity of a given infinitesimal part of the medium, with reference to the medium as a whole, due to the sound wave. The commonly used unit is the centimeter per second.

NOTE: The terms "instantaneous particle velocity," "effective particle velocity," "maximum particle velocity," and "peak particle velocity" have meanings which correspond with those of the related terms used for sound pressure.

1.365 Velocity Level.* The velocity level, in decibels, of a sound is 20 times the logarithm to the base

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*See note under Intensity Level, 1.375.

10 of the ratio of the particle velocity of the sound to the reference particle velocity. The reference particle velocity shall be stated explicitly.

NOTE: It is to be noted that in many sound fields the particle velocity ratios are not proportional to the square root of corresponding power ratios and hence cannot be expressed in decibels in the strict sense; however, it is common practice to extend the use of the decibel to these cases. (See 1.280 and 1.285.)

1.370 Sound Intensity* (Specific Sound-Energy Flux) (Sound-Energy Flux Density). The sound intensity in a specified direction at a point is the average rate of sound energy transmitted in the specified direction through a unit area normal to this direction at the point considered. The commonly used unit is the erg per second per square centimeter, but sound intensity may also be expressed in watts per square centimeter.

NOTE 1: The sound intensity in any specified direction, a, of a sound field is the sound-energy flux through a unit area normal to that direction. This is given by the expression

$$I_a = \frac{1}{T}\int_0^T p v_a dt$$

where
T = an integral number of periods or a time long compared to a period
p = the instantaneous sound pressure
v_a = the component of the instantaneous particle velocity in the direction a

NOTE 2: In the case of a free plane or spherical wave having the effective sound pressure, p, the velocity of propagation, c, in a medium of density, ρ, the intensity in the direction of propagation is given by:

$$I = \frac{p^2}{\rho c}$$

1.375 Intensity Level (Specific Sound-Energy Flux Level) (Sound-Energy Flux Density Level). The intensity level, in decibels, of a sound is 10 times the logarithm to the base 10 of the ratio of the intensity of this sound to the reference intensity. The reference intensity shall be stated explicitly.

NOTE: In discussing sound measurements made with pressure or velocity microphones, especially in enclosures involving normal modes of vibration or in sound fields containing standing waves, caution must be observed in using the terms "intensity" and "intensity level." Under such conditions it is more desirable to use the terms "pressure level" or "velocity level," since the relationship between the intensity and the pressure or velocity is generally unknown.

1.380 Sound Level. The sound level, at a point in a sound field, is the weighted sound pressure level determined in the manner specified in the American Standard Sound Level Meters for Measurement of Noise and Other Sounds, Z24.3-1944, or the latest revision thereof approved by the American Standards Association, Incorporated. (See 10.360.)

NOTE: The meter reading (in decibels) corresponds to a value of the sound pressure integrated over the audible frequency range with a specified frequency weighting and integration time.

1.385 Noise Level. Noise level is the value of noise integrated over a specified frequency range with a specified frequency weighting and integration time. It is expressed in decibels relative to a specified reference.

NOTE: In air the acoustical noise level is usually measured with a sound-level meter (see American Standard Sound Level Meters for Measurement of Noise and Other Sounds, Z24.3-1944, or the latest revision thereof approved by the American Standards Association, Incorporated), and hence is the same as the sound level of the noise. For special purposes other measuring techniques are used and must be specified.

1.390 Overload Level. The overload level of a system, component, etc, is that level at which operation ceases to be satisfactory as a result of signal distortion, overheating, damage, etc.

NOTE: In electroacoustics the overload level is most frequently set by signal distortion.

1.395 Volume. The volume in an electric circuit is the magnitude, as measured on a standard volume indicator, of a complex voice frequency wave. The volume is expressed in vu. (See 1.405.) In addition, the term "volume" is used loosely to signify either the intensity of a sound or the magnitude of an audio frequency wave.

1.400 Reference Volume. Reference volume is that magnitude of a complex electric wave, such as that corresponding to speech or music, which gives a reading of zero vu on a standard volume indicator. The sensitivity of the volume indicator is adjusted so that reference volume or zero vu is read when the instrument is connected across a 600-ohm resistance to which there is delivered a power of 1 milliwatt at 1,000 cycles per second.

1.405 Volume Unit (vu). The volume unit (vu) is a unit for expressing the magnitude of a complex electric wave, such as that corresponding to speech or music. The volume in vu is equal to the number of decibels by which the wave differs from reference volume.

1.410 Doppler Effect. The Doppler effect is the phenomenon evidenced by the change in the observed frequency of a wave in a transmission system caused by a time rate of change in the effective length of the path of travel between the source and the point of observation.

*See note under Intensity Level, 1.375.

1.415 Doppler Shift. The Doppler shift is the magnitude of the change in the observed frequency of a wave due to the Doppler effect. The unit is the cycle per second.

1.420 Sound Energy. The sound energy of a given part of a medium is the total energy in this part of the medium minus the energy which would exist in the same part of the medium with no sound waves present.

1.425 Sound-Energy Density. The sound-energy density at a point in a sound field is the sound energy contained in a given infinitesimal part of the medium divided by the volume of that part of the medium. The commonly used unit is the erg per cubic centimeter.

NOTE 1: The terms "instantaneous energy density," "maximum energy density," and "peak energy density" have meanings analogous to the related terms used for sound pressure.

NOTE 2: In speaking of average energy density in general, it is necessary to distinguish between the space average (at a given instant) and the time average (at a given point).

1.430 Sound-Energy Flux. The sound-energy flux is the average rate of flow of sound energy for one period through any specified area. The commonly used unit is the erg per second. Expressed mathematically, the sound-energy flux, J, is

$$J = \frac{1}{T}\int_0^T pSv_a dt$$

where

T = an integral number of periods or a time long compared to a period

p = the instantaneous sound pressure over the area S

v_a = the component of the instantaneous particle velocity in the direction a, normal to the area S

NOTE: In a medium of density, ρ, for a plane or spherical free wave having a velocity of propagation, c, the sound-energy flux through the area, S, corresponding to an effective sound pressure, p, is

$$J = \frac{p^2 S}{\rho c}\cos\theta$$

where

θ = the angle between the direction of propagation of the sound and the normal to the area S.

1.435 Volume Velocity. Volume velocity is the rate of flow of the medium through a specified area due to a sound wave.

NOTE: The terms "instantaneous volume velocity," "effective volume velocity," "maximum volume velocity," and "peak volume velocity" have meanings which correspond with those of the related terms used for sound pressure.

1.440 Sound Power of a Source. The sound power of a source is the total sound energy radiated by the source per unit of time. The commonly used unit is the erg per second, but the power may also be expressed in watts.

1.445 Strength of a Sound Source (Strength of a Simple Source). The strength of a sound source is the maximum instantaneous rate of volume displacement produced by the source when emitting a wave with sinusoidal time variation.

1.450 Simple Sound Source. A simple sound source is a source which radiates sound uniformly in all directions under free-field conditions.

1.455 Efficiency. The efficiency of a device with respect to a physical quantity which may be stored, transferred, or transformed by the device is the ratio of the useful output of the quantity to its total input.

NOTE: Unless specifically stated otherwise, the term "efficiency" means efficiency with respect to power.

SECTION 2

Sound Transmission and Propagation

2.005 Impedance. An impedance is the complex ratio of a force-like quantity (force, pressure, voltage, temperature, or electric field strength) to a related velocity-like quantity (velocity, volume velocity, current, heat flow, or magnetic field strength).

NOTE: The terms and definitions to which this note is appended pertain to single-frequency quantities in the steady state, and to systems whose properties are independent of the magnitudes of these quantities. These quantities can be represented mathematically by complex exponential functions of time. Under these conditions the factors involving time cancel out in the ratios called for, leaving complex numbers independent of time. Solutions based on complex exponential functions under these conditions give the solution for real sinusoidal oscillations.

Because of the similarity of electrical, mechanical, and acoustical transmission theory, the same terminology is used in the three cases. Where confusion is likely to occur, the proper term should be prefixed to the general term, *e.g.*, acoustic transfer impedance, but unless otherwise specified the definitions apply not only in acoustics but in mechanics as well. While acoustics is a branch of mechanics, it is found convenient to distinguish an acoustic system from a mechanical one whenever elastic wave motion is an essential feature.

While a strict application of the impedance concept implies the restrictions given above, it is common practice to extend the term "impedance" to situations involving nonsinusoidal quantities or nonlinear systems. Such extensions should be accompanied by an explanatory statement.

2.010 Acoustic Impedance.* The acoustic impedance of a sound medium on a given surface lying in a wave front is the complex quotient of the sound pressure (force per unit area) on that surface by the flux (volume velocity, or linear velocity multiplied by

*See note under 2.005.

the area), through the surface. When concentrated rather than distributed impedances are considered, the impedance of a portion of the medium is defined by the complex quotient of the pressure difference effective in driving that portion, by the flux (volume velocity). The acoustic impedance may be expressed in terms of mechanical impedance, acoustic impedance being equal to the mechanical impedance divided by the square of the area of the surface considered. The commonly used unit is the acoustical ohm.

NOTE: Velocities in the direction along which the impedance is to be specified are considered positive.

2.015 Specific Acoustic Impedance (Unit Area Acoustic Impedance).* The specific acoustic impedance at a point in the medium is the complex ratio of sound pressure to particle velocity.

2.020 Acoustic Resistance.* Acoustic resistance is the real component of the acoustic impedance. The commonly used unit is the acoustical ohm.

2.025 Specific Acoustic Resistance.* Specific acoustic resistance is the real component of the specific acoustic impedance.

2.030 Acoustic Reactance.* Acoustic reactance is the imaginary component of the acoustic impedance. The commonly used unit is the acoustical ohm.

2.035 Specific Acoustic Reactance.* Specific acoustic reactance is the imaginary component of the specific acoustic impedance.

2.040 Acoustical Ohm.* An acoustic resistance, reactance, or impedance has a magnitude of one acoustical ohm when a sound pressure of 1 microbar produces a volume velocity of 1 cubic centimeter per second.

2.045 Acoustic Mass (Acoustic Inertance).* Acoustic mass is the quantity which, when multiplied by 2 π times the frequency, gives the acoustic reactance associated with the kinetic energy of the medium. The commonly used unit is the gram per centimeter to the fourth power. Its dimensions are ML^{-4}.

2.050 Acoustic Stiffness.* Acoustic stiffness is the quantity which, when divided by 2 π times the frequency, gives the acoustic reactance associated with the potential energy of the medium or its boundaries. The commonly used unit is the dyne per centimeter to the fifth power. Its dimensions are $ML^{-4}T^{-2}$.

2.055 Acoustic Compliance.* Acoustic compliance is the reciprocal of acoustic stiffness. Its dimensions are $M^{-1} L^{4} T^{2}$.

*See note under 2.005.

2.060 Driving-Point Impedance.* The driving-point impedance at a driving point of a transducer is the complex ratio of the applied sinusoidal potential difference, force, or pressure to the resultant current, velocity, or volume velocity, respectively, at this point, all inputs and outputs being terminated in any specified manner.

2.065 Transfer Impedance.* The transfer impedance between two points of a transducer is the complex ratio of the applied sinusoidal potential difference, force, or pressure at one point to the resultant current, velocity, or volume velocity at the other point, all inputs and outputs being terminated in any specified manner.

2.070 Conjugate Impedances.* Conjugate impedances are impedances having resistance components which are equal and reactance components which are equal in magnitude but opposite in sign.

NOTE: Conjugate impedances are expressible by conjugate complex quantities.

2.075 Transmission Loss. In communication, transmission loss (frequently abbreviated "loss") is a general term used to denote a decrease in power in transmission from one point to another. Transmission loss is usually expressed in decibels.

2.080 Insertion Loss. The insertion loss resulting from the insertion of a transducer in a transmission system is the ratio of the power delivered to that part of the system which will follow the transducer, before insertion of the transducer, to the power delivered to that same part of the system after insertion of the transducer.

NOTE 1: If the input power, or the output power, or both consist of more than one component, the particular components used must be specified.
NOTE 2: This ratio is usually expressed in decibels.

2.085 Transducer Loss. Transducer loss is the ratio of the available power of the specified source to the power that the transducer delivers to the specified load under specified operating conditions.

NOTE 1: If the input power, or the output power, or both consist of more than one component, the particular components used must be specified.
NOTE 2: This ratio is usually expressed in decibels.
NOTE 3: The transducer loss is made up of a transition loss between the source and the transducer, a transition loss between the transducer and the load, and a dissipation loss within the transducer.

2.090 Transducer Dissipation Loss. The transducer dissipation loss of a transducer operating between specified source and load is the ratio of the power delivered by the specified source when the transducer is connected to the specified load, to the power available from the transducer when connected to the specified source.

NOTE 1: If the input power, or the output power, or both consist of more than one component, the particular components used must be specified.

NOTE 2: This ratio is usually expressed in decibels.

NOTE 3: See note 3 under 2.085.

2.095 Transition Loss. The transition loss at a discontinuity in a transmission system is the ratio of the signal power delivered to that part of the system following the discontinuity after the insertion of an ideal transducer, to the signal power delivered to that same part before the insertion. This ratio is usually expressed in decibels.

2.100 Velocity Resonance (Resonance) (Phase Resonance). Velocity resonance exists between a body, or system, and an applied sinusoidal force if any small change in the frequency of the applied force causes a decrease in velocity at the driving point; or if the frequency of the applied force is such that the absolute value of the driving-point impedance is a minimum.*

2.105 Displacement Resonance. Displacement resonance exists between a body, or system, and an applied sinusoidal force if any small change in frequency of the applied force causes a decrease in the amplitude of displacement.*

2.110 Resonant Frequency. A resonant frequency is a frequency at which resonance exists. The commonly used unit is the cycle per second.

NOTE: In cases where there is a possibility of confusion, it is necessary to specify the type of resonant frequency, *e.g.*, displacement resonant frequency or velocity resonant frequency.

2.115 Velocity Antiresonance. Velocity antiresonance exists between a body, or system, and an applied sinusoidal force if any small change in the frequency of the applied force causes an increase in velocity at the driving point, or if the frequency of an applied force is such that the absolute value of the driving-point impedance is a maximum.*

2.120 Displacement Antiresonance. Displacement antiresonance exists between a body, or system, and an applied sinusoidal force if any small change in the frequency of the applied force causes an increase in the amplitude of displacement at the driving point.*

2.125 Antiresonant Frequency. An antiresonant frequency is a frequency at which antiresonance exists.* The commonly used unit is the cycle per second.

NOTE: In cases where there is a possibility of confusion it is necessary to specify the type of antiresonant frequency, *e.g.*, displacement antiresonant frequency or velocity antiresonant frequency.

2.130 Forced Oscillation (Forced Vibration). The forced oscillation of a system is the oscillation of some physical quantity of the system when external periodic forces outside the body or system determine the period of the oscillations.

2.135 Free Oscillation (Free Vibration). The free oscillation of a system is the oscillation of some physical quantity of the system when the externally applied forces consist either of those which do no work, or of those which are derivable from a potential that is invariant during the time under consideration, or both.

2.140 Natural Frequency. A natural frequency of a body or system is a frequency of free oscillation.

*DISCUSSION: In the case of a system whose motion can be described by the equation:

$$M\frac{d^2x}{dt^2} + R\frac{dx}{dt} + Sx = A\cos\omega t$$

the characteristics of the different kinds of resonance in terms of the constants of the above equation are given in the table:

	At velocity resonance	At displacement resonance	At the natural frequency
Frequency	$\frac{1}{2\pi}\sqrt{\frac{S}{M}}$	$\frac{1}{2\pi}\sqrt{\frac{S}{M}-\frac{R^2}{2M^2}}$	$\frac{1}{2\pi}\sqrt{\frac{S}{M}-\frac{R^2}{4M^2}}$
Amplitude of displacement	$\frac{A}{R\sqrt{\frac{S}{M}}}$	$\frac{A}{R\sqrt{\frac{S}{M}-\frac{R^2}{4M^2}}}$	$\frac{A}{R\sqrt{\frac{S}{M}-\frac{3R^2}{16M^2}}}$
Amplitude of velocity	$\frac{A}{R}$	$\frac{A}{R\sqrt{1+\frac{R^2}{4MS-2R^2}}}$	$\frac{A}{R\sqrt{1+\frac{R^2}{16MS-4R^2}}}$
Phase of displacement with reference to applied force	$\frac{\pi}{2}$	$\tan^{-1}\sqrt{\frac{4MS}{R^2}-2}$	$\tan^{-1}\sqrt{\frac{16MS}{R^2}-4}$

For values of R, small compared to $\sqrt{SM}$, there is little difference between the three cases discussed above.

2.145 Natural Period. A natural period of a body or system is the period of a free oscillation of the body or system.

2.150 Normal Mode of Vibration. A normal mode of vibration is a characteristic distribution of vibration amplitudes among the parts of the system, each part of which is vibrating freely at the same frequency. Complex free vibrations are combinations of these simple vibration forms.

2.155 Fundamental Mode of Vibration. The fundamental mode of vibration of a system is the mode having the lowest frequency.

2.160 Acoustical Propagation Constant.* The acoustical propagation constant of a uniform system or of a section of a system of recurrent structures is the natural logarithm of the complex ratio of the steady-state particle velocity, volume velocities, or pressures at two points separated by unit distance in the uniform system (assumed to be of infinite length), or at two successive corresponding points in the system of recurrent structures (assumed to be of infinite length). The ratio is determined by dividing the value at the point nearer the transmitting end by the corresponding value at the more remote point.

2.165 Acoustical Attenuation Constant.* The acoustical attenuation constant is the real part of the acoustical propagation constant. The commonly used unit is the neper per section or per unit distance.

NOTE: In the case of a symmetrical structure, the real parts of both the transfer constant (see 2.185) and the acoustical propagation constant (see 2.160) are identical, and hence either one may be called simply the attenuation constant.

2.170 Acoustical Phase Constant.* The acoustical phase constant is the imaginary part of the acoustical propagation constant. The commonly used unit is the radian per section or per unit distance.

NOTE: In the case of a symmetrical structure, the imaginary parts of both the transfer constant (see 2.185) and the acoustical propagation constant (see 2.160) are identical, and have been called the "wavelength constant."

2.175 Image Impedances.* The image impedances of a transducer are the impedances which will simultaneously terminate all of its inputs and outputs in such a way that at each of its inputs and outputs the impedances in both directions are equal.

2.180 Iterative Impedance.* The iterative impedance of a transducer is that impedance which, when connected to one pair of terminals, produces a like impedance at the other pair of terminals.

NOTE 1: It follows that the iterative impedance of a transducer is the same as the impedance measured at the input terminals when an infinite number of identically similar transducers are formed into an iterative or recurrent structure of infinite length by connecting the output terminals of the first transducer to the input terminals of the second, the output terminals of the second to the input terminals of the third, etc.

NOTE 2: The iterative impedances of a four-terminal transducer are, in general, not equal to each other, but for any symmetrical transducer the iterative impedances are equal and are the same as the image impedances. The iterative impedance of a uniform line is the same as its characteristic impedance.

2.185 Transfer Constant.* The transfer constant of a transducer is one-half the natural logarithm of the complex ratio of the steady-state product of the force and the velocity, the pressure and volume velocity, or the voltage and current entering the transducer to that leaving the transducer when the latter is terminated in its image impedances.

2.190 Image Attenuation Constant.* The image attenuation constant is the real part of the transfer constant.

2.195 Image Phase Constant.* The image phase constant is the imaginary part of the transfer constant.

NOTE: The prefix "image" may be omitted when there is no danger of confusion.

2.200 Cutoff Frequency (Cutoff). A cutoff frequency of a transducer may be either a theoretical cutoff frequency or an effective cutoff frequency.

NOTE: The term "cutoff" is most commonly used with reference to wave filters and loaded lines.

2.205 Theoretical Cutoff Frequency (Theoretical Cutoff). A theoretical cutoff frequency of a transducer is a frequency at which, disregarding the effects of dissipation, the image attenuation constant changes from zero to a positive value, or vice versa.

2.210 Effective Cutoff Frequency (Effective Cutoff). An effective cutoff frequency of a transducer is a frequency at which its insertion loss between specified terminating impedances exceeds by some specified amount the loss at some reference point in the transmission band.

2.215 Force Factor*

(*a*) The force factor of an electromechanical transducer is: (1) the complex quotient of the force required to block the mechanical system divided by the corresponding current in the electric system; (2) the complex quotient of the resulting open-circuit voltage in the electric system divided by the velocity in the mechanical system.

NOTE 1: Force factors (*a*1) and (*a*2) have the same magnitude when consistent units are used and the transducer satisfies the principle of reciprocity.

*See note under 2.005.

Note 2: It is sometimes convenient in an electrostatic or piezoelectric transducer to use the ratios between force and charge or electric displacement, or between voltage and mechanical displacement.

(b) The force factor of an electroacoustic transducer is: (1) the complex quotient of the pressure required to block the acoustic system divided by the corresponding current in the electric system; (2) the complex quotient of the resulting open-circuit voltage in the electric system divided by the volume velocity in the acoustic system.

Note: Force factors (*b*1) and (*b*2) have the same magnitude when consistent units are used and the transducer satisfies the principle of reciprocity.

2.220 Blocked Impedance.* The blocked impedance of a transducer is the impedance at the input when the impedance of the output system is made infinite.

Note: For example, in the case of an electromechanical transducer, the blocked electric impedance is the impedance measured at the electric terminals when the mechanical system is blocked or clamped; the blocked mechanical impedance is measured at the mechanical side when the electric circuit is open-circuited.

2.225 Loaded Impedance.* The loaded impedance of a transducer is the impedance at the input of the transducer when the output is connected to its normal load.

2.230 Free Impedance.* The free impedance of a transducer is the impedance at the input of the transducer when the impedance of its load is made zero.

Note: The approximation is often made that the free electric impedance of an electroacoustic transducer designed for use in water is that measured with the transducer in air.

2.235 Motional Impedance* (Loaded Motional Impedance). The motional impedance of a transducer is the complex remainder after the blocked impedance has been subtracted from the loaded impedance.

2.240 Free Motional Impedance.* The free motional impedance of a transducer is the complex remainder after the blocked impedance has been subtracted from the free impedance.

2.245 Absorption Loss. Absorption loss is that part of the transmission loss due to the dissipation or conversion of sound energy into other forms of energy (*e.g.*, heat), either within the medium or attendant upon a reflection.

2.250 Divergence Loss. Divergence loss is that part of the transmission loss which is due to the divergence or spreading of the sound rays in accordance with the geometry of the system (*e.g.*, spherical waves emitted by a point source).

*See note under 2.005.

2.255 Refraction Loss. Refraction loss is that part of the transmission loss due to refraction resulting from nonuniformity of the medium.

2.260 Scattering Loss. Scattering loss is that part of the transmission loss which is due to scattering within the medium or due to roughness of the reflecting surface.

2.265 Sound Absorption. Sound absorption is the process by which sound energy is diminished in passing through a medium or in striking a surface.

2.270 Acoustic Dispersion. Acoustic dispersion is the separation of a complex sound wave into its various frequency components, usually caused by a variation with frequency of the wave velocity of the medium. The rate of change of the velocity with frequency is used as a measure of the dispersion.

2.275 Acoustic Refraction. Acoustic refraction is the variation of the direction of sound transmission due to spatial variation of the wave velocity in the medium.

2.280 Diffraction. Diffraction is that process which produces a diffracted wave.

2.285 Diffracted Wave. When a wave in a medium of certain propagation characteristics is incident upon a discontinuity or a second medium, the diffracted wave is the wave component that results in the first medium in addition to the incident wave and the waves corresponding to the reflected rays of geometrical optics.

2.290 Acoustic Scattering. Acoustic scattering is the irregular and diffuse reflection or diffraction of sound in many directions.

Note: Scattering frequently occurs when the reflecting surfaces or bodies are small compared with the wavelength of sound; in certain cases the reflecting bodies may be small inhomogeneities in the medium.

2.295 Streaming. Streaming is the production of unidirectional flow currents in a medium, arising from the presence of sound waves.

SECTION 3

Transmission Systems and Components

3.005 Acoustic Transmission System. An acoustic transmission system is an assembly of elements adapted for the transmission of sound.

3.010 Mechanical Transmission System. A mechanical transmission system is an assembly of elements adapted for the transmission of mechanical power.

3.015 Stereophonic Sound System. A stereophonic sound system is a sound system in which a plurality of microphones, transmission channels, and loudspeakers are arranged so as to provide a sensation of spatial distribution of the sound sources to the listener of the reproduction.

3.020 Transducer. A transducer is a device capable of being actuated by waves from one or more transmission systems or media and of supplying related waves to one or more other transmission systems or media.

NOTE: The waves in either input or output may be of the same or different types (*e.g.*, electric, mechanical, or acoustic).

3.025 Passive Transducer. A passive transducer is a transducer whose output waves are independent of any sources of power which are controlled by the actuating waves.

3.030 Active Transducer. An active transducer is a transducer whose output waves are dependent upon sources of power, apart from that supplied by any of the actuating waves, which are controlled by one or more of these waves.

3.035 Ideal Transducer. An ideal transducer for connecting a specified source to a specified load is a hypothetical passive transducer which transfers the maximum possible power from the source to the load.

NOTE: In linear electric circuits and analogous cases, this is equivalent to a transducer which *a*) dissipates no energy and *b*) when connected to the specified source and load presents to each its conjugate.

3.040 Linear Transducer. A linear transducer is a transducer for which the pertinent measures of all the waves concerned are linearly related.

3.045 Reversible Transducer. A reversible transducer is a transducer in which the transducer loss is independent of the direction of transmission.

3.050 Reciprocal Transducer. A reciprocal transducer is a transducer which satisfies the principle of reciprocity.

3.055 Bilateral Transducer. A bilateral transducer is a transducer which is not a unilateral transducer.

3.060 Unilateral Transducer. A unilateral transducer is a transducer which cannot be actuated at its outputs by waves in such a manner as to supply related waves at its inputs.

3.065 Electromechanical Transducer. An electromechanical transducer is a transducer for receiving waves from an electric system and delivering waves to a mechanical system, or vice versa.

3.070 Electroacoustic Transducer. An electroacoustic transducer is a transducer for receiving waves from an electric system and delivering waves to an acoustic system, or vice versa.

3.075 Symmetrical Transducer. A symmetrical transducer is a transducer whose input and output image impedances are equal.

3.080 Dissymmetrical Transducer (Dissymmetrical Network). A dissymmetrical transducer is a transducer whose input and output image impedances are not equal.

3.085 All-Pass Network. An all-pass network is a network designed to introduce phase shift or delay without introducing appreciable attenuation at any frequency.

3.090 Wave Filter (Filter). A wave filter is a transducer for separating waves on the basis of their frequency. It introduces relatively small insertion loss to waves in one or more frequency bands and relatively large insertion loss to waves of other frequencies.

3.095 Low-Pass Filter. A low-pass filter is a wave filter having a single transmission band extending from zero frequency up to some critical or cutoff frequency, not infinite.

3.100 High-Pass Filter. A high-pass filter is a wave filter having a single transmission band extending from some critical or cutoff frequency, not zero, up to infinite frequency.

3.105 Band-Pass Filter. A band-pass filter is a wave filter which has a single transmission band, neither of the critical nor cutoff frequencies being zero or infinite.

3.110 Band-Elimination Filter (Low- and High-Pass Filter). A band-elimination filter is a wave filter which has a single attenuation band, neither of the critical nor cutoff frequencies being zero or infinite.

3.115 Composite Wave Filter. A composite wave filter is a selective transducer comprising a combination of two or more filters which may be of the low-pass, high-pass, band-pass, or band-elimination type.

3.120 Constant-Resistance Structure. A constant-resistance structure is one whose iterative impedance, in at least one direction, is a resistance and is independent of the frequency.

3.125 Equivalent Network. An equivalent network is a network which, under certain conditions of use, may replace another network.

NOTE 1: The networks need not be of the same form; for example, one may be mechanical, the other electric.

NOTE 2: If one network can replace another network in any system whatsoever without altering in any way the operation of that portion of the system external to the networks, the networks are said to be "networks of general equivalence."

If one network can replace another network only in some particular system without altering in any way the operation of that portion of the system external to the networks, the networks are said to be "networks of limited equivalence." Examples of the latter are networks which are equivalent only at a single frequency, over a single band, in one direction only, or only with certain terminal conditions (such as H and T networks).

3.130 Directivity Pattern (Directional Response Pattern) (Beam Pattern). The directivity pattern of a transducer used for sound emission or reception is a description, often presented graphically, of the response of the transducer as a function of the direction of the transmitted or incident sound waves in a specified plane and at a specified frequency.

NOTE 1: A complete description of the directivity pattern of a transducer would require three-dimensional presentation.

NOTE 2: The directivity pattern is often shown as the response relative to the maximum response.

3.135 Directivity Factor

(*a*) The directivity factor of a transducer used for sound emission is the ratio of the intensity of the radiated sound at a remote point in a free field on the principal axis to the average intensity of the sound transmitted through a sphere passing through the remote point and concentric with the transducer. The frequency must be stated.

NOTE 1: The point of observation must be sufficiently remote from the transducer for spherical divergence to exist.

NOTE 2: This definition may be extended to cover the case of finite frequency bands whose spectrum must be specified.

(*b*) The directivity factor of a transducer used for sound reception is the ratio of the square of the electromotive force produced in response to sound waves arriving in a direction parallel to the principal axis to the mean square of the electromotive force that would be produced if sound waves having the same frequency and mean-square pressure were arriving at the transducer simultaneously from all directions with random phase. The frequency must be stated.

NOTE 1: For an electroacoustic transducer obeying the reciprocity principle, the directivity factor for sound reception is the same as for sound emission.

NOTE 2: This definition may be extended to cover the case of finite frequency bands whose spectrum must be specified.

3.140 Directivity Index (Directional Gain). The directivity index of a transducer is an expression of the directivity factor in decibels, *viz*, 10 times the logarithm to the base 10 of the directivity factor.

3.145 Angular Deviation Loss. The angular deviation loss of a transducer used for sound emission or reception is an expression, in decibels, of the ratio of the reference response observed on the principal axis to the transducer response at a specified angle from the principal axis. (See 3.130.)

3.150 Principal Axis. The principal axis of a transducer used for sound emission or reception is a reference direction for angular coordinates used in describing the directional characteristics of the transducer. It is usually an axis of structural symmetry, or the direction of maximum response; but if these do not coincide, the reference direction must be described explicitly.

3.155 Effective Acoustic Center. The effective acoustic center of an acoustic generator is the point from which the spherically divergent sound waves, observable at remote points, appear to diverge.

3.160 Response. The response of a device or system is a quantitative expression of the output as a function of the input under conditions which must be explicitly stated. The response characteristic, often presented graphically, gives the response as a function of some independent variable such as frequency or direction.

NOTE: Modifying phrases must be prefixed to the term "response" to indicate explicitly what measure of the output or of the input is being utilized.

3.165 Relative Response. The relative response is the ratio, usually expressed in decibels, of the response under some particular conditions to the response under reference conditions, which should be stated explicitly.

3.170 Free-Field Voltage Response (Receiving Voltage Sensitivity). The free-field voltage response of an electroacoustic transducer used for sound reception is the ratio of the voltage appearing at the output terminals of the transducer when the output terminals are open-circuited to the free-field sound pressure existing at the transducer location prior to the introduction of the transducer in the sound field. The free-field voltage response is usually expressed in decibels, *viz*, 20 times the logarithm to the base 10 of the quotient of the observed ratio divided by the reference ratio, usually 1 volt per microbar. The free-field response is defined for a plane progressive sound wave whose direction of propagation has a specified orientation with respect to the principal axis of the transducer.

3.175 Free-Field Current Response (Receiving Current Sensitivity). The free-field current response of an electroacoustic transducer used for sound reception is the ratio of the current in the output circuit of the transducer when the output terminals are short-circuited to the free-field sound pressure existing at

the transducer location prior to the introduction of the transducer in the sound field. The free-field current response is usually expressed in decibels, *viz*, 20 times the logarithm to the base 10 of the quotient of the observed ratio divided by the reference ratio, usually 1 ampere per microbar. The free-field response is defined for a plane progressive sound wave whose direction of propagation has a specified orientation with respect to the principal axis of the transducer.

3.180 Transmitting Power Response (Projector Power Response). The transmitting power response of an electroacoustic transducer used for sound emission is the ratio of the mean-square sound pressure apparent at a distance of 1 meter in a specified direction from the effective acoustic center of the transducer to the electric power input. The transmitting power response is usually expressed in decibels above a reference response of 1 microbar squared per watt of electric power input.

NOTE: The sound pressure apparent at a distance of 1 meter is determined by multiplying the sound pressure observed at a remote point where the sound field is spherically divergent by the ratio of the distance of that point, in meters, from the effective acoustic center of the transducer, to the reference distance of 1 meter.

3.185 Transmitting Voltage Response. The transmitting voltage response of an electroacoustic transducer used for sound emission is the ratio of the sound pressure apparent at a distance of 1 meter in a specified direction from the effective acoustic center of the transducer to the signal voltage applied at the electric input terminals. The transmitting voltage response is usually expressed in decibels above a reference voltage response of 1 microbar per volt.

NOTE: The sound pressure apparent at a distance of 1 meter is determined by multiplying the sound pressure observed at a remote point where the sound field is spherically divergent by the ratio of the distance of that point, in meters, from the effective acoustic center of the transducer, to the reference distance of 1 meter.

3.190 Transmitting Current Response. The transmitting current response of an electroacoustic transducer used for sound emission is the ratio of the sound pressure apparent at a distance of 1 meter in a specified direction from the effective acoustic center of the transducer to the current flowing at the electric input terminals. The transmitting current response is usually expressed in decibels above a reference current response of 1 microbar per ampere.

NOTE: The sound pressure apparent at a distance of 1 meter is determined by multiplying the sound pressure observed at a remote point where the sound field is spherically divergent by the ratio of the distance of that point, in meters, from the effective acoustic center of the transducer, to the reference distance of 1 meter.

3.195 Available Power Response. The available power response of an electroacoustic transducer used for sound emission is the ratio of the mean-square sound pressure apparent at a distance of 1 meter in a specified direction from the effective acoustic center of the transducer to the available electric power from the source. The available power response is usually expressed in decibels above the reference response of 1 microbar squared per watt of available electric power.

NOTE 1: The sound pressure apparent at a distance of 1 meter is determined by multiplying the sound pressure observed at a remote point where the sound field is spherically divergent by the ratio of the distance of that point, in meters, from the effective acoustic center of the transducer, to the reference distance of 1 meter.

NOTE 2: The available power response is a function not only of the transducer but also of some source impedance, either actual or hypothetical, the value of which must be specified.

3.200 Available Power

(a) The available power of a linear source of electric energy is the quotient of the mean square of the open-circuit terminal voltage of the source divided by four times the resistive component of the internal impedance of the source.

NOTE: The available power would be delivered to a load impedance that is the conjugate of the internal impedance of the source, and is the maximum power that can be delivered by that source.

(b) The available power of a sound field, with respect to a given object placed in it, is the power which would be abstracted from the acoustic medium by an ideal transducer having the same dimensions and the same orientation as the given object. The dimensions and their orientation with respect to the sound field must be specified. The commonly used unit is the erg per second, but the available power may also be expressed in watts.

NOTE: The acoustic power available to an electroacoustic transducer, in a plane-wave sound field of given frequency, is the product of the free-field sound intensity by the effective area of the transducer.

For this purpose the effective area of an electroacoustic transducer, for which the surface velocity distribution is independent of the manner of excitation of the transducer, is $\frac{1}{4\pi}$ times the product of the receiving directivity factor by the square of the wavelength of a free progressive wave in the medium. The commonly used unit is the square centimeter.

If the physical dimensions of the transducer are small in comparison with the wavelength, the directivity factor is near unity, and the effective area varies inversely as the square of the frequency. If the physical dimensions are large in comparison with the wavelength, the directivity factor is nearly proportional to the square of the frequency, and the effective area approaches the actual area of the active face of the transducer.

3.205 Available Power Efficiency. The available power efficiency of an electroacoustic transducer used

for sound reception is the ratio of the electric power available at the electric terminals of the transducer to the acoustic power available to the transducer.

NOTE 1: For an electroacoustic transducer which obeys the reciprocity principle, the available power efficiency in sound reception is equal to the transmitting efficiency.

NOTE 2: In a given narrow-frequency band, the available power efficiency is numerically equal to the fraction of the open-circuit mean-square thermal noise voltage present at the electric terminals which is contributed by thermal noise in the acoustic medium.

3.210 Transmitting Efficiency (Projector Efficiency). The transmitting efficiency of an electroacoustic transducer is the ratio of the total acoustic power output to the electric power input. In computing the electric power input, it is customary to omit any electric power supplied for polarization or bias.

3.215 Transducer Equivalent Noise Pressure (Equivalent Noise Pressure). The equivalent noise pressure of an electroacoustic transducer or system used for sound reception is the root-mean-square sound pressure of a sinusoidal plane progressive wave, which, if propagated parallel to the principal axis of the transducer, would produce an open-circuit signal voltage equal to the root mean square of the inherent open-circuit noise voltage of the transducer in a transmission band having a band width of 1 cycle per second and centered on the frequency of the plane sound wave.

NOTE: If the equivalent noise pressure of the transducer is a function of secondary variables, such as ambient temperature or pressure, the applicable value of these quantities should be stated explicitly.

3.220 Effective Band Width. The effective band width of a specified transmission system is the band width of an ideal system which (*a*) has uniform transmission in its pass band equal to the maximum transmission of the specified system, and (*b*) transmits the same power as the specified system when the two systems are receiving equal input signals having a uniform distribution of energy at all frequencies.

NOTE: This may be expressed mathematically as follows:

$$\text{Effective band width} = \int_0^\infty G\,df$$

where f is the frequency in cycles per second and G is the ratio of the power transmission at the frequency, f, to the transmission at the frequency of maximum transmission.

3.225 Electric-Network Reciprocity Theorem. In an electric network composed of passive bilateral linear impedances, the ratio of an electromotive force introduced in any branch to the current measured in any other branch, called the transfer impedance, is equal in magnitude and phase to the ratio that would be observed if the positions of the electromotive force and the current were interchanged.

NOTE: When altering the location of an electromotive force in a network, the branch into which the electromotive force is to be introduced must be opened, while the branch from which it has been removed must be closed.

3.230 Acoustical Reciprocity Theorem. In an acoustic system comprising a fluid medium having bounding surfaces S_1, S_2, S_3, . . . , and subject to no impressed body forces, if two distributions of normal velocities v_n' and v_n'' of the bounding surfaces produce pressure fields p' and p'', respectively, throughout the region, then the surface integral of $(p''v_n' - p'v_n'')$ over all the bounding surfaces S_1, S_2, S_3, . . . , vanishes.

NOTE: If the region contains only one simple source, the theorem reduces to the form ascribed to Helmholtz, *viz*, in a region as described, a simple source at A produces the same sound pressure at another point B as would have been produced at A had the source been located at B.

3.235 Electroacoustical Reciprocity Theorem. For an electroacoustic transducer satisfying the reciprocity principle, the quotient of the magnitude of the ratio of the open-circuit voltage at the output terminals (or the short-circuit output current) of the transducer, when used as a sound receiver, to the free-field sound pressure referred to an arbitrarily selected reference point on or near the transducer, divided by the magnitude of the ratio of the sound pressure apparent at a distance, *d*, from the reference point to the current flowing at the transducer input terminals (or the voltage applied at the input terminals), when used as a sound emitter, is a constant, called the "reciprocity constant," independent of the type or constructional details of the transducer.

NOTE: The reciprocity constant is given by

$$\left|\frac{M_0}{S_0}\right| = \left|\frac{M_s}{S_s}\right| = \frac{2d}{\rho f} \cdot 10^{-7},$$

where

M_0 is the free-field voltage response as a sound receiver, in open-circuit volts per microbar, referred to the arbitrary reference point on or near the transducer

M_s is the free-field current response in short-circuit amperes per microbar, referred to the arbitrary reference point on or near the transducer

S_0 is the sound pressure produced at a distance d centimeters from the arbitrary reference point in microbars per ampere of input current

S_s is the sound pressure produced at a distance d centimeters from the arbitrary reference point in microbars per volt applied at the input terminals

f is the frequency in cycles per second

ρ is the density of the medium in grams per centimeter^3

d is the distance in centimeters from the arbitrary reference point on or near the transducer to the point at which the sound pressure established by the transducer when emitting is evaluated

SECTION 4

Ultrasonics

4.005 Ultrasonics. Ultrasonics is the general subject of sound in the frequency range above about 15 kilocycles per second.

4.010 Supersonics. Supersonics is the general subject covering phenomena associated with speed higher than the speed of sound (as in case of aircraft and projectiles traveling faster than sound).

NOTE: This term has been used in acoustics synonymously with "ultrasonics." Such usage is now deprecated.

4.015 Ultrasonic Generator. An ultrasonic generator is a device for the production of sound waves of ultrasonic frequency.

4.020 Ultrasonic Detector. An ultrasonic detector is a device for the detection and measurement of ultrasonic waves.

NOTE: Such devices may be mechanical, electrical, thermal, or optical in nature.

4.025 Ultrasonic Stroboscope. An ultrasonic stroboscope is a light interrupter whose action is based on the modulation of a light beam by an ultrasonic field.

4.030 Ultrasonic Delay Line (Ultrasonic Storage Cell). An ultrasonic delay line is a contained medium (usually a liquid, *e.g.*, mercury) in which use is made of the propagation time of sound to obtain a time delay of a signal.

4.035 Ultrasonic Light Diffraction. Ultrasonic light diffraction is the formation of optical diffraction spectra when a beam of light is passed through a longitudinal wave field. The diffraction results from the periodic variation of the light refraction in the sound field.

4.040 Ultrasonic Space Grating (Grating). An ultrasonic space grating is a periodic spatial variation of the index of refraction caused by the presence of acoustic waves within the medium.

4.045 Ultrasonic Cross Grating (Multiple Grating). An ultrasonic cross grating is a space grating resulting from the crossing of beams of ultrasonic waves having different directions of propagation. This may be two- or three-dimensional.

4.050 Ultrasonic Grating Constant. The ultrasonic grating constant is the distance between diffracting centers of the sound wave which is producing particular light-diffraction spectra.

4.055 Striation Technique. Striation technique is a method for rendering sound waves visible by using their individual ability to refract light waves.

4.060 Ultrasonic Material Dispersion. Ultrasonic material dispersion is the production of suspensions or emulsions of one material in another due to the action of high-intensity ultrasonic waves.

4.065 Ultrasonic Coagulation. Ultrasonic coagulation is the bonding of small particles into larger aggregates by the action of ultrasonic waves.

SECTION 5

Hearing and Speech

5.005 Pitch. Pitch is that attribute of auditory sensation in terms of which sounds may be ordered on a scale extending from low to high, such as a musical scale.

NOTE 1: Pitch depends primarily upon the frequency of the sound stimulus, but it also depends upon the sound pressure and wave form of the stimulus.

NOTE 2: The pitch of a sound may be described by the frequency of that simple tone, having a specified sound pressure or loudness level, which seems to the average normal ear to produce the same pitch.

5.010 Mel. The mel is a unit of pitch. By definition, a simple tone of frequency 1000 cycles per second, 40 decibels above a listener's threshold, produces a pitch of 1000 mels. The pitch of any sound that is judged by the listener to be n times that of a 1-mel tone is n mels.

5.015 Loudness. Loudness is the intensive attribute of an auditory sensation, in terms of which sounds may be ordered on a scale extending from soft to loud.

NOTE: Loudness depends primarily upon the sound pressure of the stimulus, but it also depends upon the frequency and wave form of the stimulus.

5.020 Sone. The sone is a unit of loudness. By definition, a simple tone of frequency 1000 cycles per second, 40 decibels above a listener's threshold, produces a loudness of 1 sone. The loudness of any sound that is judged by the listener to be n times that of the 1-sone tone is n sones.

NOTE 1: A millisone is equal to 0.001 sone.

NOTE 2: The loudness scale is a relation between loudness and level above threshold (see 5.055) for a particular listener. In presenting data relating loudness in sones to sound pressure level, or in averaging the loudness scales of several listeners, the thresholds (measured or assumed) should be specified.

NOTE 3: The term "loudness unit" has been used for the basic subdivision of a loudness scale based on group judgment on which a loudness level of 40 phons has a loudness of approximately 1000 loudness units. For example, see Figure 1 of American Standard for Noise Measurement, Z24.2-1942.

5.025 Loudness Level. The loudness level, in phons, of a sound is numerically equal to the sound pressure level in decibels, relative to 0.0002 microbar, of a

simple tone of frequency 1000 cycles per second which is judged by the listeners to be equivalent in loudness.

5.030 Phon. The phon is the unit of loudness level as specified in definition 5.025.

5.035 Loudness Contours. Loudness contours are curves which show the related values of sound pressure level and frequency required to produce a given loudness sensation for the typical listener.

5.040 Threshold of Audibility (Threshold of Detectability). The threshold of audibility for a specified signal is the minimum effective sound pressure of the signal that is capable of evoking an auditory sensation in a specified fraction of the trials. The characteristics of the signal, the manner in which it is presented to the listener, and the point at which the sound pressure is measured must be specified.

NOTE 1: Unless otherwise indicated, the ambient noise reaching the ears is assumed to be negligible.

NOTE 2: The threshold may be expressed in decibels relative to 0.0002 microbar or to 1 microbar.

NOTE 3: Instead of the method of constant stimuli, which is implied by the phrase "a specified fraction of the trials," another psychophysical method (which should be specified) may be employed.

5.045 Threshold of Feeling (or Discomfort, Tickle, or Pain). The threshold of feeling (or discomfort, tickle, or pain) for a specified signal is the minimum effective sound pressure of that signal which, in a specified fraction of the trials, will stimulate the ear to a point at which there is the sensation of feeling (or discomfort, tickle, or pain).

NOTE 1: Characteristics of the signal and the measuring technique must be specified in every case.

NOTE 2: This threshold is customarily expressed in decibels relative to 0.0002 microbar or 1 microbar.

5.050 Auditory Sensation Area

(*a*) Auditory sensation area is the region enclosed by the curves defining the threshold of feeling and the threshold of audibility as functions of frequency.

(*b*) Auditory sensation area is the part of the brain (temporal lobe of the cortex) which is responsive to auditory stimuli.

5.055 Level Above Threshold (Sensation Level). The level above threshold of a sound is the pressure level of the sound in decibels above its threshold of audibility for the individual observer.

5.060 Masking. Masking is the amount by which the threshold of audibility of a sound is raised by the presence of another (masking) sound. The unit customarily used is the decibel.

5.065 Air Conduction. Air conduction is the process by which sound is conducted to the inner ear through the air in the outer ear canal as part of the pathway.

5.070 Bone Conduction. Bone conduction is the process by which sound is conducted to the inner ear through the cranial bones.

5.075 Hearing Loss (Deafness). The hearing loss of an ear at a specified frequency is the ratio, expressed in decibels, of the threshold of audibility for that ear to the normal threshold. (See, also, American Standard Specification for Audiometers for General Diagnostic Purposes, Z24.5-1951, or the latest revision thereof approved by the American Standards Association, Incorporated.)

5.080 Hearing Loss for Speech. Hearing loss for speech is the difference in decibels between the speech levels at which the average normal ear and the defective ear, respectively, reach the same intelligibility, often arbitrarily set at 50 percent.

5.085 Percent Hearing Loss (Percent Deafness). The percent hearing loss at a given frequency is 100 times the ratio of the hearing loss in decibels to the number of decibels between the normal threshold levels of audibility and feeling.

NOTE 1: A weighted mean of the percent hearing losses at specified frequencies is often used as a single measure of the loss of hearing.

NOTE 2: The American Medical Association has defined percentage loss of hearing for medicolegal use. (See the Journal of the American Medical Association, Vol 133, pp 396 and 397, February 8, 1947.)

5.090 Percent Hearing. The percent hearing at any given frequency is 100 minus the percent hearing loss at that frequency.

5.095 Audiogram (Threshold Audiogram). An audiogram is a graph showing hearing loss, percent hearing loss, or percent hearing as a function of frequency.

5.100 Masking Audiogram. A masking audiogram is a graphical presentation of the masking due to a stated noise. This is plotted, in decibels, as a function of the frequency of the masked tone.

5.105 Difference Limen (Differential Threshold) (Just Noticeable Difference). A difference limen is the increment in a stimulus which is just noticed in a specified fraction of the trials. The relative difference limen is the ratio of the difference limen to the absolute magnitude of the stimulus to which it is related.

5.110 Aural Harmonic. An aural harmonic is a harmonic generated in the auditory mechanism.

5.115 Electrophonic Effect. Electrophonic effect is the sensation of hearing produced when an alternating current of suitable frequency and magnitude from an external source is passed through an animal.

5.120 Articulation (Percent Articulation) and Intelligibility (Percent Intelligibility). Percent articulation or percent intelligibility of a communication system is the percentage of the speech units spoken by a talker or talkers that is understood correctly by a listener or listeners.

The word "articulation" is customarily used when the contextual relations among the units of the speech material are thought to play an unimportant role; the word "intelligibility" is customarily used when the context is thought to play an important role in determining the listener's perception.

NOTE 1: It is important to specify the type of speech material and the units into which it is analyzed for the purpose of computing the percentage. The units may be fundamental speech sounds, syllables, words, sentences, etc.

NOTE 2: The percent articulation or percent intelligibility is a property of the entire communication system: talker, transmission equipment or medium, and listener. Even when attention is focused upon one component of the system (*e.g.*, a talker, a radio receiver), the other components of the system should be specified.

5.125 Syllable Articulation (Percent Syllable Articulation).* Syllable articulation is the percent articulation obtained when the speech units considered are syllables (usually meaningless and usually of the consonant-vowel-consonant type).

5.130 Sound Articulation (Percent Sound Articulation).* Sound articulation is the percent articulation obtained when the speech units considered are fundamental sounds (usually combined into meaningless syllables).

5.135 Vowel Articulation (Percent Vowel Articulation).* Vowel articulation is the percent articulation obtained when the speech units considered are vowels (usually combined with consonants into meaningless syllables).

5.140 Consonant Articulation (Percent Consonant Articulation).* Consonant articulation is the percent articulation obtained when the speech units considered are consonants (usually combined with a vowel into meaningless syllables).

5.145 Discrete Word Intelligibility.* Discrete word intelligibility is the percent intelligibility obtained when the speech units considered are words (usually presented so as to minimize the contextual relation between them).

*See notes under 5.120.

5.150 Discrete Sentence Intelligibility.* Discrete sentence intelligibility is the percent intelligibility obtained when the speech units considered are sentences (usually of simple form and content).

5.155 Instantaneous Speech Power. The instantaneous speech power is the rate at which sound energy is being radiated by a speech source at any given instant.

5.160 Peak Speech Power. The peak speech power is the maximum value of the instantaneous speech power within the time interval considered.

5.165 Average Speech Power. The average speech power for any given time interval is the average value of the instantaneous speech power over that interval.

SECTION 6

Music†

6.005 Tone

(a) A tone is a sound wave capable of exciting an auditory sensation having pitch.

(b) A tone is a sound sensation having pitch.

6.010 Simple Tone (Pure Tone)

(a) A simple tone is a sound wave, the instantaneous sound pressure of which is a simple sinusoidal function of the time.

(b) A simple tone is a sound sensation characterized by its singleness of pitch.

6.015 Complex Tone

(a) A complex tone is a sound wave produced by the combination of simple sinusoidal components of different frequencies.

(b) A complex tone is a sound sensation characterized by more than one pitch.

6.020 Fundamental Tone

(a) The fundamental tone is the component in a periodic wave corresponding to the fundamental frequency. (See 1.095.)

† Other terms pertinent to music are to be found in Section 1, General Definitions, and Section 5, Hearing and Speech. Some terms in music are used to refer both to the production of sound waves and to the nature of the associated sensation. There is often not complete correspondence between the two; which of the two meanings is desired must be made clear from the context or units of measurement. In the definitions of this section, for example, when a tone is described as having pitch, the context thus indicates that the sound sensation is meant, whereas, if the tone has frequency, the sound wave is meant.

(b) The fundamental tone is the component tone of lowest pitch in a complex tone.

6.025 Overtone

(a) An overtone is a physical component of a complex sound having a frequency higher than that of the basic frequency. (See 6.030.)

(b) An overtone is a component of a complex tone having a pitch higher than that of the fundamental pitch.

NOTE: The term "overtone" has frequently been used in place of "harmonic," the nth harmonic being called the (n—1)st overtone. There is, however, ambiguity sometimes in the numbering of components of a complex sound when the word overtone is employed. Moreover, the word "tone" has many different meanings, so that it is preferable to employ terms which do not involve "tone" wherever possible.

6.030 Partial

(a) A partial is a physical component of a complex tone.

(b) A partial is a component of a sound sensation which may be distinguished as a simple tone that cannot be further analyzed by the ear and which contributes to the character of the complex sound.

NOTE 1: The frequency of a partial may be either higher or lower than the basic frequency and may or may not be an integral multiple or submultiple of the basic frequency. (For definition of basic frequency, see 1.100.) If the frequency is not a multiple or submultiple, the partial is inharmonic.

NOTE 2: When a system is maintained in steady forced vibration at a basic frequency equal to one of the frequencies of the normal modes of vibration of the system, the partials in the resulting complex tone are not necessarily identical in frequency with those of the other normal modes of vibration.

6.035 Harmonic. A harmonic is a partial whose frequency is an integral multiple of the fundamental frequency.

NOTE: The above definition is in musical terms. (For the definition in physical terms, see 1.105.)

6.040 Harmonic Series of Sounds. A harmonic series of sounds is one in which each basic frequency in the series is an integral multiple of a fundamental frequency.

6.045 Note. A note is a conventional sign used to indicate the pitch, or the duration, or both, of a tone sensation. It is also the sensation itself or the vibration causing the sensation. The word serves when no distinction is desired among the symbol, the sensation, and the physical stimulus.

6.050 Timbre (Musical Quality). Timbre is that attribute of auditory sensation in terms of which a listener can judge that two sounds similarly presented and having the same loudness and pitch are dissimilar.

NOTE: Timbre depends primarily upon the spectrum of the stimulus, but it also depends upon the wave form, the sound pressure, and the frequency location of the spectrum of the stimulus.

6.055 Vibrato. The vibrato is a musical embellishment which depends primarily upon periodic variations of frequency which are often accompanied by variations in amplitude and wave form.

6.060 Interval. The interval between two sounds is their spacing in pitch or frequency, whichever is indicated by the context. The frequency interval is expressed by the ratio of the frequencies or by a logarithm of this ratio.

6.065 Octave. An octave is the interval between two sounds having a basic frequency ratio of two. By extension, the octave is the interval between any two frequencies having the ratio 2:1.

NOTE: The interval, in octaves, between any two frequencies is the logarithm to the base two (or 3.322 times the logarithm to the base 10) of the frequency ratio.

6.070 Whole Tone (Whole Step). A whole tone is the interval between two sounds whose basic frequency ratio is approximately equal to the sixth root of two.

6.075 Semitone (Half Step). A semitone is the interval between two sounds whose basic frequency ratio is approximately equal to the twelfth root of two.

NOTE: The interval, in equally tempered semitones, between any two frequencies, is 12 times the logarithm to the base 2 (or 39.86 times the logarithm to the base 10) of the frequency ratio.

6.080 Cent. A cent is the interval between two sounds whose basic frequency ratio is the twelve-hundredth root of two.

NOTE: The interval, in cents, between any two frequencies is 1200 times the logarithm to the base 2 of the frequency ratio. Thus, 1200 cents = 12 equally tempered semitones = 1 octave.

6.085 Scale. A musical scale is a series of notes (symbols, sensations, or stimuli) arranged from low to high by a specified scheme of intervals, suitable for musical purposes.

6.090 Pythagorean Scale. A Pythagorean scale is a musical scale such that the frequency intervals are represented by the ratios of integral powers of the numbers 2 and 3.

6.095 Just Scale. A just scale is a musical scale formed by taking three consecutive triads each having the ratio 4:5:6, or 10:12:15. (See Table 6.1.)

NOTE: By consecutive triads is meant triads such that the highest note of one is the lowest note of the other.

6.100 Equally Tempered Scale. An equally tempered scale is a series of notes selected from a division of the octave (usually) into 12 equal intervals. (See Table 6.3.)

6.105 Standard Pitch. The Standard Pitch is based on the tone "A" of 440 cycles per second. (See Table 6.4.)

NOTE 1: With this standard the frequency of Middle C is 261.6 cycles per second. (See Table 6.4.)

NOTE 2: Musical instruments are to be capable of complying with this standard when played where the ambient temperature is 22 C (72 F).

TABLE 6.1
Some Just Intervals
(See 6.095)

Name of Interval	Frequency Ratio	Cents
Unison	1:1	
Semitone	16:15	111.731
Minor tone or lesser whole tone	10:9	182.404
Major tone or greater whole tone	9:8	203.910
Minor third	6:5	315.641
Major third	5:4	386.314
Perfect fourth	4:3	498.045
Augmented fourth	45:32	590.224
Diminished fifth	64:45	609.777
Perfect fifth	3:2	701.955
Minor sixth	8:5	813.687
Major sixth	5:3	884.359
Harmonic minor seventh	7:4	968.826
Grave minor seventh	16:9	996.091
Minor seventh	9:5	1017.597
Major seventh	15:8	1088.269
Octave	2:1	1200.000

TABLE 6.2
Some Small Intervals

Name of Interval	Description	Frequency Ratio	Cents
Comma of Didymus	excess of greater whole tone over lesser whole tone	81:80	21.506
Comma of Pythagoras	excess of 12 Pythagorean fifths over 7 octaves	531441:524288	23.460
Skhisma	excess of Pythagorean over Didymean comma (almost exactly equal to the difference between a Pythagorean and an equally tempered perfect fifth)	32805:32768	1.954

TABLE 6.3
Equally Tempered Intervals
(See 6.100)

Name of Interval	Frequency Ratio	Cents
Unison	1:1	0
Minor second or semitone	1.059463:1	100
Major second or whole tone	1.122462:1	200
Minor third	1.189207:1	300
Major third	1.259921:1	400
Perfect fourth	1.334840:1	500
Augmented fourth Diminished fifth	1.414214:1	600
Perfect fifth	1.498307:1	700
Minor sixth	1.587401:1	800
Major sixth	1.681793:1	900
Minor seventh	1.781797:1	1000
Major seventh	1.887749:1	1100
Octave	2:1	1200

TABLE 6.4
Frequencies of the Tones of the Usual Equally Tempered Scale, Arranged by Corresponding Piano Key Numbers, and Based on the A of 440 Cycles per Second
(See 6.105)

Note Name	Key No.	Freq cps	Key No.	Freq cps	Key No.	Freq cps	Key No.	Freq cps	Key No.	Freq cps	Key No.	Freq cps	Key No.	Freq cps	Key No.	Freq cps	Note Name
A	1	27.500	13	55.000	25	110.000	37	220.000	49	440.000	61	880.000	73	1760.000	85	3520.000	*A*
A♯—*B*♭	2	29.135	14	58.270	26	116.541	38	233.082	50	466.164	62	932.328	74	1864.655	86	3729.310	*A*♯—*B*♭
B	3	30.868	15	61.735	27	123.471	39	246.942	51	493.883	63	987.767	75	1975.533	87	3951.066	*B*
C	4	32.703	16	65.406	28	130.813	40	261.626	52	523.251	64	1046.502	76	2093.005	88	4186.009	*C*
C♯—*D*♭	5	34.648	17	69.296	29	138.591	41	277.183	53	554.365	65	1108.731	77	2217.461			*C*♯—*D*♭
D	6	36.708	18	73.416	30	146.832	42	293.665	54	587.330	66	1174.659	78	2349.318			*D*
D♯—*E*♭	7	38.891	19	77.782	31	155.563	43	311.127	55	622.254	67	1244.508	79	2489.016			*D*♯—*E*♭
E	8	41.203	20	82.407	32	164.814	44	329.628	56	659.255	68	1318.510	80	2637.021			*E*
F	9	43.654	21	87.307	33	174.614	45	349.228	57	698.456	69	1396.913	81	2793.826			*F*
F♯—*G*♭	10	46.249	22	92.499	34	184.997	46	369.994	58	739.989	70	1479.978	82	2959.955			*F*♯—*G*♭
G	11	48.999	23	97.999	35	195.998	47	391.995	59	783.991	71	1567.982	83	3135.964			*G*
G♯—*A*♭	12	51.913	24	103.826	36	207.652	48	415.305	60	830.609	72	1661.219	84	3322.438			*G*♯—*A*♭

SECTION 7

Architectural Acoustics

7.005 Sound Absorption. Sound absorption is the process by which sound energy is diminished in passing through a medium or in striking a surface.

7.010 Sabin (Square Foot Unit of Absorption). A sabin is a measure of the sound absorption of a surface. It is the equivalent of 1 square foot of a perfectly absorptive surface.

7.015 Sound-Absorption Coefficient (Acoustical Absorptivity). The sound-absorption coefficient of a surface is the fraction of incident sound energy absorbed by the surface or medium.

NOTE 1: The surface is considered part of an infinite area.
NOTE 2: The value of the coefficient is a function of the angle of incidence of the sound.

7.020 Sound-Reflection Coefficient (Acoustical Reflectivity). The sound-reflection coefficient of a surface not a generator is the ratio of the rate of flow of sound energy reflected from the surface, on the side of incidence, to the incident rate of flow. Unless otherwise specified, all possible directions of incident flow are assumed to be equally probable. Also, unless otherwise stated, the values given apply to a portion of an infinite surface, thus eliminating edge effects.

7.025 Sound-Transmission Coefficient (Acoustical Transmittivity). The sound-transmission coefficient of an interface or septum is the ratio of the transmitted to incident sound energy. The value of the coefficient is a function of the angle of incidence of the sound.

7.030 Reverberation Time. The reverberation time for a given frequency is the time required for the average sound-energy density, originally in a steady state, to decrease after the source is stopped to one-millionth of its initial value (60 db).

NOTE: Usually the pressure level for the upper part of this range is measured and the result extrapolated to cover 60 db.

7.035 Mean Free Path. The mean free path for sound waves in an enclosure is the average distance sound travels between successive reflections in the enclosure.

7.040 Live Room. A live room is a room which is characterized by an unusually small amount of sound absorption.

7.045 Dead Room. A dead room is a room which is characterized by an unusually large amount of sound absorption.

7.050 Reverberation Chamber. A reverberation chamber is an enclosure in which all of the surfaces have been made as sound-reflective as possible. Reverberation chambers are used for certain acoustical measurements.

SECTION 8

Recording and Reproducing

8.005 Sound Recording System. A sound recording system is a combination of transducing devices and associated equipment suitable for storing sound in a form capable of subsequent reproduction.

8.010 Sound Reproducing System. A sound reproducing system is a combination of transducing devices and associated equipment for reproducing recorded sound.

8.015 Re-recording System. A re-recording system is an association of reproducers, mixers, amplifiers, and recorders capable of being used for combining or modifying various sound recordings to provide a final sound record. Recording of speech, music, and sound effects may be so combined.

8.020 Multitrack Recording System. A multitrack recording system is a recording system which provides two or more recording paths on a medium, which may carry either related or unrelated recordings in common time relationship.

8.025 Recording Channel. The term "recording channel" refers to one of a number of independent recorders in a recording system or to independent recording tracks on a recording medium.

NOTE: One or more channels may be used at the same time for covering different ranges of the transmitted frequency band, for multichannel recording, or for control purposes.

8.030 Instantaneous Recording. An instantaneous recording is a recording which is intended for direct reproduction without further processing.

8.035 Playback. Playback is an expression used to denote reproduction of a recording.

8.040 Mixer. A mixer, in a sound transmission recording, or reproducing system, is a device having two or more inputs, usually adjustable, and a common output, which operates to combine linearly, in a desired proportion, the separate input signals to produce an output signal.

NOTE: The term is also sometimes applied to the operator of the above device.

8.045 Frequency-Response Equalization (Equalization). Frequency-response equalization is the effect

of all frequency discriminative means employed in a transmission system to obtain a desired over-all frequency response.

8.050 Pre-emphasis (Pre-equalization). In recording, pre-emphasis is an arbitrary change in the frequency response of a recording system from its basic response (such as constant velocity or amplitude) for the purpose of improvement in signal-to-noise ratio, or the reduction of distortion.

8.055 De-emphasis (Postemphasis) (Post-equalization). De-emphasis is usually a form of equalization complementary to pre-emphasis.

8.060 Ground Noise. In recording and reproducing, ground noise is the residual system noise in the absence of the signal. It is usually caused by inhomogeneity in the recording and reproducing media, but may also include amplifier noise such as tube noise or noise generated in resistive elements in the input of the reproducer amplifier system.

8.065 Background Noise. In recording and reproducing, background noise is the total system noise independent of whether or not a signal is present. The signal is not to be included as part of the noise.

8.070 Modulation Noise (Noise Behind the Signal). The modulation noise is the noise caused by the signal. The signal is not to be included as part of the noise.

NOTE: The term is used where the noise level is a function of the strength of the signal.

8.075 Frequency Record. A frequency record is a recording of various known frequencies at known amplitudes, usually for the purposes of testing or measuring.

8.080 Re-recording. Re-recording is the process of making a recording by reproducing a recorded sound source and recording this reproduction. (See 8.085.)

8.085 Dubbing. Dubbing is a term used to describe the combining of two or more sources of sound into a complete recording, at least one of the sources being a recording. (See 8.080.)

8.090 Magnetic Recorder. A magnetic recorder is equipment incorporating an electromagnetic transducer and means for moving a ferromagnetic recording medium relative to the transducer for recording electric signals as magnetic variations in the medium.

NOTE: The generic term "magnetic recorder" can also be applied to an instrument which has not only facilities for recording electric signals as magnetic variations, but also for converting such magnetic variations back into electric variations.

8.095 Magnetic Recording Medium. A magnetic recording medium is a magnetizable material used in a magnetic recorder for retaining the magnetic variations imparted during the recording process. It may have the form of a wire, tape, cylinder, disk, etc.

8.100 Magnetic Tape. Magnetic tape is a magnetic recording medium having a width greater than approximately 10 times the thickness. This tape may be homogeneous or coated.

8.105 Magnetic Powder-Coated Tape (Coated Tape). Magnetic powder-coated tape is a tape consisting of a coating of uniformly dispersed, powdered ferromagnetic material on a nonmagnetic base.

8.110 Magnetic Powder-Impregnated Tape (Impregnated Tape) (Dispersed Magnetic Powder Tape). Magnetic powder-impregnated tape is a magnetic tape which consists of magnetic particles uniformly dispersed in a nonmagnetic material.

8.115 Magnetic Wire. Magnetic wire is a magnetic recording medium, approximately circular in cross section.

8.120 Magnetic Plated Wire. Magnetic plated wire is a magnetic wire having a core of nonmagnetic material and a plated surface of ferromagnetic material.

8.125 Magnetic Recording Reproducer. A magnetic recording reproducer is equipment for converting magnetic variations on magnetic recording media into electric variations.

8.130 Magnetic Head. In magnetic recording, a magnetic head is a transducer for converting electric variations into magnetic variations for storage on magnetic media, for reconverting energy so stored into electric energy, or for erasing such stored energy.

8.135 Magnetic Recording Head. In magnetic recording, a magnetic recording head is a magnetic head for transforming electric variations into magnetic variations for storage on magnetic media.

8.140 Magnetic Reproducing Head. In magnetic recording, a magnetic reproducing head is a magnetic head for converting magnetic variations on magnetic media into electric variations.

8.145 Erasing Head. An erasing head is a device for obliterating any previous recordings. It may be used for preconditioning the magnetic media for recording purposes.

8.150 A-C Erasing Head. An a-c erasing head is one which uses alternating current to produce the magnetic field necessary for erasing.

NOTE: A-c erasing is achieved by subjecting the medium to

a number of cycles of a magnetic field of a decreasing magnitude. The medium is, therefore, essentially magnetically neutralized.

8.155 D-C Erasing Head. A d-c erasing head is one which uses direct current to produce the magnetic field necessary for erasing.

NOTE: D-c erasing is achieved by subjecting the medium to a unidirectional field. Such a medium is, therefore, in a different magnetic state than one erased by alternating current.

8.160 P-M Erasing Head. A p-m erasing head is one which uses the fields of one or more permanent magnets for erasing.

8.165 Double Pole-Piece Magnetic Head. A double pole-piece magnetic head is a magnetic head having two separate pole pieces in which pole faces of opposite polarity are on opposite sides of the medium. One or both of these pole pieces may be provided with an energizing winding.

8.170 Single Pole-Piece Magnetic Head. A single pole-piece magnetic head is a magnetic head having a single pole piece on one side of the recording medium.

8.175 Ring Head. A ring head is a magnetic head in which the magnetic material forms an enclosure with one or more air gaps. The magnetic recording medium bridges one of these gaps and is in contact with or in close proximity to the pole pieces on one side only.

8.180 Gap Length. In longitudinal magnetic recording, the gap length is the physical distance between adjacent surfaces of the pole pieces of a magnetic head. (See 8.130.)

NOTE: The effective gap length is usually greater than the physical length and can be experimentally determined in some cases.

8.185 Magnetic Biasing. Magnetic biasing is the simultaneous conditioning of the magnetic recording medium during recording by superposing an additional magnetic field upon the signal magnetic field.

NOTE: In general, magnetic biasing is used to obtain a substantially linear relationship between the amplitude of the signal and the remanent flux density in the recording medium.

8.190 A-C Magnetic Biasing. A-c magnetic biasing is magnetic biasing accomplished by the use of an alternating current, usually well above the signal frequency range.

8.195 D-C Magnetic Biasing. D-c magnetic biasing is magnetic biasing accomplished by the use of direct current.

8.200 Longitudinal Magnetization. Longitudinal magnetization in magnetic recording is magnetization of the recording medium in a direction essentially parallel to the line of travel.

8.205 Perpendicular Magnetization. Perpendicular magnetization in magnetic recording is magnetization of the recording medium in a direction perpendicular to the line of travel, and parallel to the smallest cross-sectional dimension of the medium.

NOTE: In this type of magnetization, either single pole-piece or double pole-piece magnetic heads may be used.

8.210 Transverse Magnetization. Transverse magnetization in magnetic recording is magnetization of the recording medium in a direction perpendicular to the line of travel and parallel to the greatest cross-sectional dimension.

8.215 Magnetic Printing (Magnetic Transfer) (Crosstalk*). Magnetic printing is the permanent transfer of a recorded signal from a section of a magnetic recording medium to another section of the same or a different medium when these sections are brought in proximity.

8.220 Photographic Sound Recorder (Optical Sound Recorder). A photographic sound recorder is equipment incorporating means for producing a modulated light beam and means for moving a light-sensitive medium relative to the beam for recording signals derived from sound signals.

8.225 Light Modulator. A light modulator is the combination of a source of light, an appropriate optical system, and a means for varying the resulting light beam (such as a galvanometer or light valve), so that a sound track may be produced.

8.230 Aeolight. An Aeolight is a glow lamp employing a cold cathode and a mixture of permanent gases in which the intensity of illumination varies with the applied signal voltage.

8.235 Light Valve. A light valve is a device whose light transmission can be made to vary in accordance with an externally applied electrical quantity, such as a voltage, current, electric field, magnetic field, or electron beam.

8.240 Galvanometer Recorder (for Photographic Recording). A galvanometer recorder for photographic recording is a combination of mirror and coil suspended in a magnetic field. The application of a signal voltage to the coil causes a reflected light beam from the mirror to pass across a slit in front of a moving photographic film, thus providing a photographic record of the signal.

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* Deprecated

8.245 Sound Track. A sound track is a narrow band, usually along the margin of a sound film, which carries the sound record. In some cases, a plurality of such bands may be used.

8.250 Class-A Push-Pull Sound Track. A class-A push-pull sound track consists of two single tracks side by side, the transmission of one being 180 degrees out of phase with the transmission of the other. Both positive and negative halves of the sound wave are linearly recorded on each of the two tracks.

8.255 Class-B Push-Pull Sound Track. A class-B push-pull sound track consists of two tracks, side by side, one of which carries the positive half of the signal only, and the other the negative half. During the inoperative half cycle, each track transmits little or no light.

8.260 Control Track. A control track is a supplementary sound track, usually placed on the same film with the sound track carrying the program material. Its purpose is to control, in some respect, the reproduction of the sound track. Ordinarily, it contains one or more tones, each of which may be modulated either as to amplitude or frequency.

8.265 Multiple Sound Track. A multiple sound track consists of a group of sound tracks, printed adjacently on a common base, independent in character but in a common time relationship, *e.g.*, two or more have been used for stereophonic sound recording.

8.270 Squeeze Track. A squeeze track is a variable-density sound track wherein, by means of adjustable masking of the recording light beam and simultaneous increase of the electrical signal applied to the light modulator, a track having variable width with greater signal-to-noise ratio is obtained.

8.275 Single Track (Standard Track). A single track is a variable-density or variable-area sound track in which both positive and negative halves of the signal are linearly recorded.

8.280 Variable-Area Track. A variable-area track is a sound track divided laterally into opaque and transparent areas, a sharp line of demarcation between these areas forming an oscillographic trace of the wave shape of the recorded signal.

8.285 Unilateral-Area Track. A unilateral-area track is a sound track in which one edge only of the opaque area is modulated in accordance with the recorded signal. There may, however, be a second edge modulated by a noise-reduction device.

8.290 Bilateral-Area Track. A bilateral-area track is a sound track having the two edges of the central area modulated according to the signal.

8.295 Variable-Density Track. A variable-density track is a sound track of constant width and usually, but not necessarily, of uniform light transmission on any instantaneous tranverse axis and of which the average light transmission varies along the longitudinal axis in proportion to some characteristic of the applied signal.

8.300 Photographic Sound Reproducer (Optical Sound Reproducer). A photographic sound reproducer is a combination of light source, optical system, photoelectric cell, or other light-sensitive device such as a photo conductive cell, and a mechanism for moving a medium carrying an optical sound record (usually film), by means of which the recorded variations may be converted into electric signals of approximately like form.

8.305 Scoring System. A scoring system for motion picture production is a recording system used for recording music to be reproduced in timed relationship with a motion picture.

8.310 Photographic Emulsion. Photographic emulsion is the light-sensitive coating on photographic film consisting usually of a gelatine containing silver halide.

8.315 Transmission (Transmittance). Transmission, as applied to photographic recording, is the ratio of the light flux transmitted by the medium to the light flux incident upon it. Transmission may be either diffuse or specular.

8.320 Opacity. Opacity of an optical path is the reciprocal of transmission. (See 8.315.)

8.325 Photographic Transmission Density* (Optical Density). Photographic transmission density is the common logarithm of opacity. Hence, film transmitting 100 percent of the light has a density of zero, transmitting 10 percent, a density of 1, etc. Density may be diffuse, specular, or intermediate. Conditions must be specified.

8.330 Diffuse Transmission Density.* Diffuse transmission density is the value of the photographic transmission density obtained when the light flux impinges normally on the sample and all the transmitted flux is collected and measured.

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*For details of measurement and specifications see American Standard Diffuse Transmission Density, Z38.2.5-1946, or the latest edition thereof approved by the American Standards Association, Incorporated.

8.335 Specular Transmission Density.* Specular transmission density is the value of the photographic density obtained when the light flux impinges normally on the sample and only the normal component of the transmitted flux is collected and measured.

8.340 Densitometer. A densitometer is an instrument for the measurement of optical density (photographic transmission, photographic reflection, visual transmission, etc) of a material.

8.345 Sensitometry. Sensitometry is the measurement of the light-response characteristics of photographic film under specified conditions of exposure and development.

8.350 Grain. A grain of photographic material is a small particle of metallic silver remaining in a photographic emulsion after development and fixing. In the agglomerate, these grains form the dark area of a photographic image.

8.355 Graininess. Graininess of a photographic material is the visible coarseness under specified conditions due to silver grains in a developed photographic film.

8.360 H and D Curve (Hurter and Driffield Curve). An H and D curve is a characteristic curve of a photographic emulsion which is a plot of density against the logarithm of exposure. It is used for the control of photographic processing, and for defining the response characteristics to light of photographic emulsions.

8.365 Gamma. The gamma of a photographic material is the slope of the straight line portion of the H and D curve. It represents the rate of change of photographic density with the logarithm of exposure. Gamma is a measure of the contrast properties of the film. Both gamma and density specifications are commonly used as controls in the processing of photographic film.

8.370 Toe and Shoulder (of an H and D Curve). Toe and shoulder are the terms applied to the nonlinear portions of the H and D curve which lie respectively below and above the straight portion of this curve.

8.375 Noise Reduction. In photographic recording and reproducing, noise reduction is a process whereby the average transmission of the sound track of the print (averaged across the track) is decreased for signals of low level and increased for signals of high level.

NOTE: Since the background noise introduced by the sound track is less at low transmission, this process reduces film noise during soft passages. The effect is normally accomplished automatically.

8.380 Mechanical Phonograph Recorder (Mechanical Recorder). A mechanical phonograph recorder is an equipment for transforming electric or acoustic signals into mechanical motion of approximately like form and inscribing such motion in an appropriate medium by cutting or embossing.

8.385 Disk Recorder. A disk recorder is a mechanical recorder in which the recording medium has the geometry of a disk.

8.390 Lateral Recording. A lateral recording is a mechanical recording in which the groove modulation is perpendicular to the motion of the recording medium and parallel to the surface of the recording medium.

8.395 Vertical Recording (Hill and Dale Recording). A vertical recording is a mechanical recording in which the groove modulation is in a direction perpendicular to the surface of the recording medium.

8.400 Constant-Amplitude Recording. Constant-amplitude recording indicates a mechanical recording characteristic wherein, for a fixed amplitude of a sinusoidal signal, the resulting recorded amplitude is independent of frequency.

8.405 Constant-Velocity Recording. Constant-velocity recording indicates a mechanical recording characteristic wherein, for a fixed amplitude of a sinusoidal signal, the resulting recorded amplitude is inversely proportional to the frequency.

8.410 Cutter (Mechanical Recording Head). A cutter is an electromechanical transducer which transforms an electric input into a mechanical output, typified by mechanical motions which may be inscribed into a recording medium by a cutting stylus.

8.415 Magnetic Cutter. A magnetic cutter is a cutter in which the mechanical displacements of the recording stylus are produced by the action of magnetic fields.

8.420 Crystal Cutter. A crystal cutter is a cutter in which the mechanical displacements of the recording stylus are derived from the deformations of a crystal having piezoelectric properties.

8.425 Advance Ball. An advance ball is a rounded support (often sapphire) attached to a cutter which rides on the surface of the recording medium so as to

*See footnote on page 30.

maintain a uniform mean depth of cut and correct for small irregularities of the disk surface.

8.430 Phonograph Pickup (Mechanical Reproducer) (Playback Head). A phonograph pickup is a mechanoelectrical transducer which is actuated by modulations present in the groove of the recording medium and which transforms this mechanical input into an electric output.

NOTE: Where no confusion will result, the term "phonograph pickup" may be shortened to "pickup."

8.435 Acoustic Pickup (Sound Box). An acoustic pickup is a device which transforms groove modulations directly into acoustical vibrations.

8.440 Capacitor Pickup. A capacitor pickup is a phonograph pickup which depends for its operation upon the variation of its electric capacitance.

8.445 Crystal Pickup (Piezoelectric Pickup). A crystal pickup is a phonograph pickup which depends for its operation on the generation of an electric charge by the deformation of a body (usually crystalline) having piezoelectric properties.

8.450 Variable-Reluctance Pickup (Magnetic Pickup). A variable-reluctance pickup is a phonograph pickup which depends for its operation on the variation in the reluctance of a magnetic circuit.

8.455 Variable-Resistance Pickup. A variable-resistance pickup is a phonograph pickup which depends for its operation upon the variation of a resistance.

8.460 Variable-Inductance Pickup. A variable-inductance pickup is a phonograph pickup which depends for its operation on the variation of its inductance.

8.465 Moving-Coil Pickup (Dynamic Reproducer). A moving-coil pickup is a phonograph pickup, the electric output of which results from the motion of a conductor or coil in a magnetic field.

8.470 Light-Beam Pickup. A light-beam pickup is a phonograph pickup in which a beam of light is a coupling element of the transducer.

8.475 Pickup Arm (Tone Arm). A pickup arm is a pivoted arm arranged to hold a pickup.

8.480 Pickup Cartridge. A pickup cartridge is the removable portion of a pickup containing the electromechanical translating elements and the reproducing stylus.

8.485 Recording Stylus.* A recording stylus is a tool which inscribes the groove into the recording medium.

8.490 Cutting Stylus.* A cutting stylus is a recording stylus with a sharpened tip which, by removing material, cuts a groove into the recording medium.

8.495 Embossing Stylus.* An embossing stylus is a recording stylus with a rounded tip which displaces the material in the recording medium to form a groove.

8.500 Burnishing Surface. A burnishing surface, in mechanical recording, is the portion of the cutting stylus directly behind the cutting edge which smooths the groove.

8.505 Reproducing Stylus.* A reproducing stylus is a mechanical element adapted to following the modulations of a record groove and transmitting the mechanical motion thus derived to the pickup mechanism.

8.510 Stylus Drag (Needle Drag). Stylus drag is an expression used to denote the force resulting from friction between the surface of the recording medium and the reproducing stylus.

8.515 Stylus Force (Static Stylus Force) (Vertical Stylus Force) (Needle Force) (Stylus Pressure†). The stylus force is the vertical force exerted on a stationary recording medium by the stylus when in its operating position.

8.520 Side Thrust. Side thrust, in disk recording, is the radial component of force on a pickup arm caused by the stylus drag.

8.525 Offset Angle. In lateral disk reproduction, the offset angle is the smaller of the two angles between the projections into the plane of the disk of the vibration axis of the pickup stylus and the line connecting the vertical pivot (assuming a horizontal disk) of the pickup arm with the stylus point.

8.530 Tracking Error. Tracking error, in lateral mechanical recording, is the angle between the vibration axis of the mechanical system of the pickup and a plane containing the tangent to the unmodulated record groove which is perpendicular to the surface of the recording medium at the point of needle contact.

8.535 Shaving. In mechanical recording, shaving is the process of removing material from the surface of a recording medium for the purpose of obtaining a new recording surface.

8.540 Chip. The chip, in mechanical recording, is the material removed from the recording medium by the recording stylus while cutting the groove.

* Stylus is a term defining a pickup needle or a holder furnished with a jewel or other abrasive-resistant tip. A stylus may or may not be arranged for convenient replacement.

† Deprecated

8.545 Lacquer Recording. A lacquer recording is any recording made on a lacquer recording medium.

8.550 Lacquer Disks (Cellulose Nitrate Disks). Lacquer disks are mechanical recording disks usually made of metal, glass, or paper, and coated with a lacquer compound (often containing cellulose nitrate).

8.555 Acetate Disks. Acetate disks are mechanical recording disks, either solid or laminated, which are made of various acetate compounds.

8.560 Laminated Record. A laminated record is a mechanical recording medium composed of several layers of material. Normally, it is made with a thin face of surface material on each side of a core.

8.565 Core. A core, in mechanical recording, is the central layer or basic support of certain types of laminated media.

8.570 Master. A master is a metal part, normally derived from a disk recording by electroforming, which is a negative of the recording, *i.e.*, a master has ridges instead of grooves and thus cannot be played with a pointed stylus.

8.575 Original Master (Metal Master) (Metal Negative) (No. 1 Master). An original master, in disk recording, is the master produced by electroforming from the face of a wax or lacquer recording.

8.580 No. 2, No. 3, etc, Master. A No. 2, No. 3, etc, master is a master produced by electroforming from a No. 1, No. 2, etc, mold.

8.585 Mold. In disk recording, a mold is a metal part derived from a master by electroforming which is a positive of the recording, *i.e.*, it has grooves similar to a recording and thus can be played in a manner similar to a record.

8.590 No. 1 Mold (Mother) (Metal Positive). A No. 1 mold is a mold derived by electroforming from the original master.

8.595 No. 2, No. 3, etc, Mold. A No. 2, No. 3, etc, mold is a mold derived by electroforming from a No. 2, No. 3, etc, master.

8.600 Stamper. A stamper is a negative (generally made of metal by electroforming) from which finished pressings are molded.

8.605 Backed Stamper. A backed stamper is a thin metal stamper which is attached to a backing material, generally a metal disk of desired thickness.

8.610 Preform (Biscuit*). In disk recording, a preform is a small slab of record stock material as it is prepared for use in the record presses.

8.615 Pressing. In disk recording, a pressing is a record produced in a record-molding press from a master or stamper.

8.620 Binder. A binder is a resinous material which causes the various materials of a record compound to adhere to one another.

8.625 Filler. Filler, in mechanical recording, is the inert material of a record compound as distinguished from the binder.

8.630 Wax Original (Wax Master*). A wax original is an original recording on a wax surface for the purpose of making a master.

8.635 Lacquer Original (Lacquer Master*). A lacquer original is an original recording on a lacquer surface for the purpose of making a master.

8.640 Cake Wax. Cake wax is a thick disk of wax upon which an original mechanical disk recording may be inscribed.

8.645 Flowed Wax. Flowed wax is a mechanical recording medium, in disk form, prepared by melting and flowing wax onto a metal base.

8.650 Wax. In mechanical recording, wax refers to a blend of waxes with metallic soaps. (See also 8.640.)

8.655 Sputtering (Cathode Sputtering). Sputtering is a process sometimes used in the production of the metal master wherein the original is coated with an electric conducting layer by means of an electric discharge in a vacuum.

NOTE: This is done prior to electroplating a heavier deposit.

8.660 Land. The land is the record surface between two adjacent grooves of a mechanical recording.

8.665 Groove. A groove, in mechanical recording, is the track inscribed in the record by the cutting or embossing stylus, including undulations or modulations caused by the vibration of the stylus.

8.670 Unmodulated Groove (Blank Groove). An unmodulated groove, in mechanical recording, is a groove made in the medium with no signal applied to the cutter.

8.675 Locked Groove (Concentric Groove). A locked groove, in disk recording, is a blank and continuous groove at the end of modulated grooves whose function is to prevent further travel of the pickup.

8.680 Eccentric Groove (Eccentric Circle). An eccentric groove, in disk recording, is a locked groove

* Deprecated

whose center is other than that of the disk record (generally used in connection with mechanical control of phonographs).

8.685 Fast Groove (Fast Spiral). A fast groove, in disk recording, is an unmodulated spiral groove having a pitch that is much greater than that of the recorded grooves.

8.690 Lead-In Groove (Lead-In Spiral). A lead-in groove, in disk recording, is a blank spiral groove at the beginning of a record generally having a pitch that is much greater than that of the recorded grooves.

8.695 Lead-Over Groove (Crossover Spiral). A lead-over groove, in disk recording, is a groove cut between recordings of small durations which enables the pickup stylus to travel from one cut to the next.

8.700 Lead-Out Groove (Throw-Out Spiral). A lead-out groove, in disk recording, is a blank spiral groove at the end of a recording generally of a pitch that is much greater than that of the recorded grooves and which is connected to either the locked or eccentric groove.

8.705 Groove Angle. Groove angle, in disk recording, is the angle between the two walls of an unmodulated groove in a radial plane perpendicular to the surface of the recording medium.

8.710 Groove Shape. Groove shape, in disk recording, is the contour of the groove in a radial plane perpendicular to the surface of the recording medium.

8.715 Groove Speed. Groove speed, in disk recording, is the linear speed of the groove with respect to the stylus.

8.720 Guard Circle. A guard circle is an inner concentric groove inscribed, on disk records, to prevent the pickup from being damaged by being thrown to the center of the record.

8.725 Drive Pin. A drive pin, in disk recording, is a pin similar to the center pin, but located to one side thereof, which is used to prevent a disk record from slipping on the turntable.

8.730 Drive-Pin Hole. A drive-pin hole, in disk recording, is a hole in a disk record which accommodates the turntable drive pin.

8.735 Grouping. Grouping is nonuniform spacing between the grooves of a disk recording.

8.740 Overcutting. In disk recording, overcutting is the effect of excessive level characterized by one groove cutting through into an adjacent one.

8.745 Eccentricity. Eccentricity, in disk recording, is the displacement of the center of the recording groove spiral, with respect to the record center hole.

8.750 Pinch Effect. In disk recording, the pinch effect is a pinching of the reproducing stylus tip twice each cycle in the reproduction of lateral recordings due to a decrease of the groove angle cut by the recording stylus when it is moving across the record as it swings from a negative to a positive peak.

8.755 Poid. A poid is the curve traced by the center of a sphere when it rolls or slides over a surface having a sinusoidal profile.

8.760 Transition Frequency (Crossover Frequency) (Turnover Frequency). The transition frequency of a disk recording system is the frequency corresponding to the point of intersection of the asymptotes to the constant amplitude and the constant velocity portions of its frequency response curve. This curve is plotted with output voltage ratio in decibels as the ordinate and the logarithm of the frequency as the abscissa.

8.765 Recording Loss. Recording loss, in mechanical recording, is the loss in recorded level whereby the amplitude of the wave in the recorded medium differs from the amplitude executed by the recording stylus.

8.770 Translation Loss (Playback Loss). Translation loss is the loss in the reproduction of a mechanical recording whereby the amplitude of motion of the reproducing stylus differs from the recorded amplitude in the medium.

8.775 Optical Pattern (Christmas Tree Pattern). In mechanical recording, an optical pattern is a pattern which is observed when the surface of a record is illuminated by a light beam of essentially parallel rays.

8.780 Tracing Distortion. Tracing distortion is the nonlinear distortion introduced in the reproduction of mechanical recording because the curve traced by the motion of the reproducing stylus is not an exact replica of the modulated groove. For example, in the case of a sine-wave modulation in vertical recording the curve traced by the center of the tip of a stylus is a poid.

8.785 Surface Noise. In mechanical recording, surface noise is the noise component in the electric output of a pickup due to irregularities in the contact surface of the groove. (See 8.060.)

8.790 Rumble (Turntable Rumble). Rumble is low-frequency vibration mechanically transmitted to the recording or reproducing turntable and superimposed on the reproduction.

SECTION 9

Underwater Sound

9.005 Underwater Sound Projector. An underwater sound projector is a transducer used to produce sound in water.

NOTE: Where no confusion will result, the term "underwater sound projector" may be shortened to "projector."

9.010 Hydrophone. A hydrophone is an electroacoustic transducer which responds to water-borne sound waves and delivers essentially equivalent electric waves.

NOTE: In a manner similar to the use of the adjective "line" in the definition of line hydrophone (9.015), and line microphone (10.035), the adjectives "pressure," "velocity," "gradient," "omnidirectional," "unidirectional," "carbon," "capacitor," "crystal," "magnetic," "magnetostriction," "moving-coil," and "moving-conductor," when applied to a hydrophone, have meanings similar to those that apply in the case of a microphone. (See 10.010, etc.)

9.015 Line Hydrophone. A line hydrophone is a directional hydrophone consisting of a single, straight-line element or an array of contiguous or spaced electroacoustic transducing elements disposed on a straight line, or the acoustical equivalent of such an array.

9.020 Split Projector. A split projector is a directional projector in which electroacoustic transducing elements are so divided and arranged that each division may be energized separately through its own electric terminals.

9.025 Split Hydrophone. A split hydrophone is a directional hydrophone in which electroacoustic transducing elements are so divided and arranged that each division may induce a separate electromotive force between its own electric terminals.

9.030 Shading. Shading is a method of controlling the directivity pattern of a transducer through control of the distribution of phase and amplitude of the transducer action over the active face.

9.035 Cavitation. Cavitation is the formation of local cavities in a liquid as a result of the reduction of total pressure.

9.040 Standard Sea Water Conditions. Standard sea water conditions are those of sea water at a static pressure of 1 atmosphere, a temperature of 15 C, and a salinity such that the velocity of propagation is exactly 1500 meters per second.

NOTE: Under these conditions, the following other properties are derived from experimental data:

Salinity[1] $S = 31.60$ parts per thousand
Density[2] $\rho = 1.02338$ grams per cubic centimeter
Characteristic acoustic impedance, $\rho c = 1.53507 \times 10^5$ cgs units
Pressure spectrum level of thermal noise[3], $10 \log_{10} (kT\rho c)$ = 82.17 db below 1 microbar

This standard is adopted for the purpose of establishing consistent relationships between acoustical quantities which involve the properties of the sound medium. It is not intended for calibration of echo range or depth scales.

The standard values have been chosen to represent closely the average conditions on continental shelves except in tropical waters. The values likely to be encountered under actual conditions will usually lie between the limits given in Table 9.1.

[1]S. Kuwahara: Velocity of sound in sea-water and calculation of the velocity for use in sonic sounding. *Hydrographic Review*, **16**, 123-140 (1939).

[2]Martin Knudsen: *Hydrographical Tables.* Copenhagen, 1901, 1931.

[3]*Smithsonian Physical Tables.* 8th Edition, 1934.

TABLE 9.1

Representative Water Conditions
(See 9.040)

	Fresh Water		Sea Water			
Salinity (parts per 1000)	0		30		36	
Temperature (degrees Centigrade)	4	25	5	20	15	25
Velocity (meters per second)	1418.3	1493.2	1461.0	1513.2	1505.0	1532.8
Density (grams per cm^3)	1.00000	0.99707	1.02375	1.02099	1.02677	1.02412
Characteristic impedance $\times 10^{-5}$ (cgs units)	1.4183	1.4888	1.4957	1.5450	1.5453	1.5698

Hydrostatic pressure increases the velocity by 0.018 meters per second per meter of depth. It also increases the density by approximately 0.0000045 grams per cm^3 per meter of depth.

SECTION 10

General Acoustical Apparatus

10.005 Microphone. A microphone is an electroacoustic transducer which responds to sound waves and delivers essentially equivalent electric waves. (See 10.145.)

10.010 Pressure Microphone. A pressure microphone is a microphone in which the electric output substantially corresponds to the instantaneous sound pressure of the impressed sound waves.

NOTE: A pressure microphone is a gradient microphone (see 10.025) of zero order and is nondirectional when its dimensions are small compared to a wave length.

10.015 Velocity Microphone. A velocity microphone is a microphone in which the electric output substantially corresponds to the instantaneous particle velocity in the impressed sound wave.

NOTE: A velocity microphone is a gradient microphone (see 10.025) of order one, and it is inherently bidirectional.

10.020 Phase-Shift Microphone. A phase-shift microphone is a microphone employing phase-shift networks to produce directional properties.

10.025 Gradient Microphone. A gradient microphone is a microphone the output of which corresponds to a gradient of the sound pressure.

NOTE: Gradient microphones may be of any order as, for example, zero, first, second, etc. A pressure microphone is a gradient microphone of zero order. A velocity microphone is a gradient microphone of order one. Mathematically, from a directivity standpoint for plane waves the rms response is proportional to $\cos^n \theta$, where θ is the angle of incidence, and n is the order of the microphone.

10.030 Combination Microphone. A combination microphone is a microphone consisting of a combination of two or more similar or dissimilar microphones.

NOTE: Examples of combination microphones are: Two oppositely phased pressure microphones acting as a gradient microphone, and a pressure microphone and a velocity microphone acting as a unidirectional microphone.

10.035 Line Microphone. A line microphone is a directional microphone consisting of a single, straight-line element, or an array of contiguous or spaced electroacoustic transducing elements, disposed on a straight line, or the acoustical equivalent of such an array.

10.040 Parabolic-Reflector Microphone. A parabolic-reflector microphone is a microphone employing a parabolic reflector to improve its directivity and sensitivity.

10.045 Omnidirectional Microphone (Nondirectional Microphone). An omnidirectional microphone is a microphone the response of which is essentially independent of the direction of sound incidence.

NOTE: It should be noted that, in this case, omnidirectional refers to elevation as well as azimuth. In radio antenna practice this is not necessarily the case.

10.050 Directional Microphone. A directional microphone is a microphone the response of which varies significantly with the direction of sound incidence.

10.055 Bidirectional Microphone. A bidirectional microphone is a microphone in which the response predominates for sound incidences of 0 degrees and 180 degrees. (See 3.150.)

10.060 Unidirectional Microphone. A unidirectional microphone is a microphone which is responsive predominantly to sound incident from one hemisphere.

10.065 Carbon Microphone. A carbon microphone is a microphone which depends for its operation upon the variation in resistance of carbon contacts.

10.070 Electrostatic Microphone (Capacitor Microphone) (Condenser Microphone). An electrostatic microphone is a microphone which depends for its operation upon variations of its electrostatic capacitance.

10.075 Crystal Microphone (Piezoelectric Microphone). A crystal microphone is a microphone which depends for its operation on the generation of an electric charge by the deformation of a body (usually crystalline) having piezoelectric properties.

10.080 Electronic Microphone. An electronic microphone is a microphone which depends for its operation on the generation of a voltage by the motion of one of the electrodes in a vacuum tube.

10.085 Hot-Wire Microphone. A hot-wire microphone is a microphone which depends for its operation on the change in resistance of a hot wire produced by the cooling or heating effects of a sound wave.

10.090 Variable-Reluctance Microphone (Magnetic Microphone) (Electromagnetic Microphone) (Moving Iron Microphone). A variable-reluctance microphone is a microphone which depends for its operation on variations in the reluctance of a magnetic circuit.

10.095 Magnetostriction Microphone. A magnetostriction microphone is a microphone which depends for its operation on the generation of an elec-

tromotive force by the deformation of a material having magnetostrictive properties.

10.100 Moving-Coil Microphone (Dynamic Microphone). A moving-coil microphone is a moving-conductor microphone in which the movable conductor is in the form of a coil.

10.105 Moving-Conductor Microphone. A moving-conductor microphone is a microphone the electric output of which results from the motion of a conductor in a magnetic field.

10.110 Push-Pull Microphone. A push-pull microphone is a microphone which makes use of two like microphone elements actuated by the same sound waves and operating 180 degrees out of phase.

10.115 Ribbon Microphone. A ribbon microphone is a moving-conductor microphone in which the moving conductor is in the form of a ribbon which is directly driven by the sound waves.

10.120 Antinoise Microphone. An antinoise microphone is a microphone with characteristics which discriminate against acoustic noise.

10.125 Close-Talking Microphone. A close-talking microphone is a microphone designed particularly for use close to the mouth of the speaker.

10.130 Lapel Microphone. A lapel microphone is a microphone adapted to positioning on the clothing of the user.

10.135 Lip Microphone. A lip microphone is a microphone adapted for use in contact with the lip.

10.140 Mask Microphone. A mask microphone is a microphone designed for use inside of an oxygen or other type of respiratory mask.

10.145 Telephone Transmitter. A telephone transmitter is a microphone for use in a telephone system. (See 10.005.)

10.150 Throat Microphone. A throat microphone is a microphone normally actuated by mechanical contact with the throat.

10.155 Acoustic Generator. An acoustic generator is a transducer which converts electric, mechanical, or other forms of energy into sound.

10.160 Telephone Receiver. A telephone receiver is an earphone for use in a telephone system. (See 10.165.)

10.165 Earphone (Receiver). An earphone is an electroacoustic transducer intended to be closely coupled acoustically to the ear.

NOTE: The term "receiver" should be avoided when there is risk of ambiguity.

10.170 Insert Earphones. Insert earphones are small earphones which fit partially inside the ear.

10.175 Loudspeaker (Speaker) (Loud Speaker*). A loudspeaker is an electroacoustic transducer usually intended to radiate acoustic power effectively at a distance in air.

NOTE: The term "speaker" should be avoided when there is risk of ambiguity.

10.180 Electrostatic Loudspeaker (Capacitor Loudspeaker) (Condenser Loudspeaker). An electrostatic loudspeaker is a loudspeaker in which the mechanical forces are produced by the action of electrostatic fields.

10.185 Crystal Loudspeaker (Piezoelectric Loudspeaker). A crystal loudspeaker is a loudspeaker in which the mechanical displacements are produced by piezoelectric action.

10.190 Excited Field Loudspeaker. An excited field loudspeaker is a loudspeaker in which the steady magnetic field is produced by an electromagnet.

10.195 Induction Loudspeaker. An induction loudspeaker is a loudspeaker in which the current which reacts with the steady magnetic field is induced in the moving member.

10.200 Magnetic Armature Loudspeaker (Magnetic Loudspeaker*). A magnetic armature loudspeaker is a loudspeaker comprising a ferromagnetic armature actuated by forces of magnetic attraction.

10.205 Magnetostriction Loudspeaker. A magnetostriction loudspeaker is a loudspeaker in which the mechanical displacement is derived from the deformation of a material having magnetostrictive properties.

10.210 Moving-Coil Loudspeaker (Dynamic Loudspeaker). A moving-coil loudspeaker is a moving-conductor loudspeaker in which the moving conductor is in the form of a coil conductively connected to a source of electric energy.

10.215 Loudspeaker Voice Coil. A loudspeaker voice coil is the moving coil of a moving-coil loudspeaker.

10.220 Moving-Conductor Loudspeaker. A moving-conductor loudspeaker is a loudspeaker in which

* Deprecated

the mechanical forces result from magnetic reactions between the field of the current in a moving conductor and a steady magnetic field.

10.225 Permanent-Magnet Loudspeaker. A permanent-magnet loudspeaker is a moving-conductor loudspeaker in which the steady field is produced by means of a permanent magnet.

10.230 Pneumatic Loudspeaker. A pneumatic loudspeaker is a loudspeaker in which the acoustic output results from controlled variation of an air stream.

10.235 Horn Loudspeaker. A horn loudspeaker is a loudspeaker in which the radiating element is coupled to the medium by means of a horn.

10.240 Acoustic Horn (Horn). An acoustic horn is a tube of varying cross section having different terminal areas which provide a change of acoustic impedance and control of the directivity pattern.

10.245 Conical Horn. A conical horn is a horn whose cross-sectional area increases as the square of the axial length.

10.250 Exponential Horn. An exponential horn is a horn whose cross-sectional area increases exponentially with axial distance.

NOTE:
If

S = the area of a plane section normal to the axis of the horn at a distance x from the throat of the horn

S_0 = the area of the plane section normal to the axis of the horn at the throat

m = a constant which determines the rate of taper or flare of the horn

then

$$S = S_0 \epsilon^{mx}$$

10.255 Multicellular Horn. A multicellular horn is a cluster of horns with juxtaposed mouths which lie in a common surface. The purpose of the cluster is to control the directional pattern of the radiated energy.

10.260 Horn Mouth. The horn mouth is normally the end of a horn with the larger cross-sectional area.

10.265 Horn Throat. The horn throat is normally the end of a horn with the smaller cross-sectional area.

10.270 Direct Radiator Loudspeaker. A direct radiator loudspeaker is a loudspeaker in which the radiating element acts directly on the air.

10.275 Acoustic Radiating Element. An acoustic radiating element is a vibrating surface in a transducer which can cause or be actuated by sound waves.

10.280 Reflex Baffle. A reflex baffle is a loudspeaker baffle in which a portion of the radiation from the rear of the diaphragm is propagated forward after controlled shift of phase or other modification, the purpose being to increase the over-all radiation in some portion of the frequency spectrum.

10.285 Loudspeaker System. A loudspeaker system is a combination of one or more loudspeakers and all associated baffles, horns, and dividing networks arranged to work together as a coupling means between the driving electric circuit and the acoustic medium.

10.290 Dividing Network (Loudspeaker Dividing Network). A dividing network is a frequency selective network which divides the spectrum to be radiated into two or more parts.

10.295 Crossover Frequency. As applied to electric dividing networks, the crossover frequency is the frequency at which equal electric powers are delivered to each of the adjacent frequency channels when all channels are terminated in the loads specified.

10.300 Acoustic Interferometer. An acoustic interferometer is an instrument for measuring the velocity or frequency of sound waves in a liquid or gas by observing the variations of sound pressure in a standing wave established in the medium between a sound source and a reflector, as the reflector is moved or the frequency is varied.

10.305 Acoustic Radiometer. An acoustic radiometer is an instrument for measuring sound intensity by determining the unidirectional steady-state pressure caused by the reflection or absorption of a sound wave at a boundary.

10.310 Artificial Ear. An artificial ear is a device for the measurement of earphones which presents an acoustic impedance to the earphone equivalent to the impedance presented by the average human ear. It is equipped with a microphone for measurement of the sound pressures developed by the earphone.

10.315 Artificial Voice. An artificial voice is a small loudspeaker mounted in a shaped baffle which is proportioned to simulate the acoustical constants of the human head. The artificial voice is used for calibrating and testing close-talking microphones.

10.320 Audiometer. An audiometer is an instrument for measuring hearing acuity. Measurements may be made with speech signals, usually recorded, or with tone signals.

NOTE: Specifications for a pure tone audiometer for general diagnostic purposes are covered by American Standard Specifications for Audiometers for General Diagnostic Purposes, Z24.5-1951, or the latest revision thereof approved by the American Standards Association, Incorporated.

10.325 Baffle. A baffle is a shielding structure or partition used to increase the effective length of the external transmission path between two points in an acoustic system as, for example, between the front and back of an electroacoustic transducer.

NOTE: In the case of a loudspeaker, a baffle is often used to increase the acoustic loading of the diaphragm.

10.330 Earphone Coupler. An earphone coupler is a cavity of predetermined shape which is used for the testing of earphones. It is provided with a microphone for the measurement of pressures developed in the cavity.

NOTE 1: Couplers generally have a volume of 6 cubic centimeters for testing regular earphones and a volume of 2 cubic centimeters for testing insert earphones.

NOTE 2: Specifications for couplers are given in the Proposed American Standard Method for the Coupler Calibration of Earphones, Z24.9-1949, or the latest revision thereof approved by the American Standards Association, Incorporated.

10.335 Electrostatic Actuator. An electrostatic actuator is an apparatus constituting an auxiliary external electrode which permits the application of known electrostatic forces to the diaphragm of a microphone for the purpose of obtaining a primary calibration.

10.340 Pistonphone. A pistonphone is a small chamber equipped with a reciprocating piston of measurable displacement which permits the establishment of a known sound pressure in the chamber.

10.345 Rayleigh Disk. A Rayleigh disk is a special form of acoustic radiometer which is used for the fundamental measurement of particle velocity.

10.350 Reverberation Time Meter. A reverberation time meter is an instrument for measuring the reverberation time of an enclosure.

10.355 Sound Analyzer. A sound analyzer is a device for measuring the band pressure level or pressure spectrum level of a sound as a function of frequency.

10.360 Sound-Level Meter. A sound-level meter is an instrument including a microphone, an amplifier, an output meter, and frequency weighting networks for the measurement of noise and sound levels in a specified manner; the measurements are intended to approximate the loudness level which would be obtained by the more elaborate ear balance method.

NOTE: Specifications for sound-level meters for measurement of noise and other sounds are given in American Standard Sound Level Meters for Measurement of Noise and Other Sounds, Z24.3-1944, or the latest revision thereof approved by the American Standards Association, Incorporated.

10.365 Sound Probe. A sound probe is a device for exploring a sound field without significantly disturbing the field in the region being explored.

NOTE: A sound probe may take the form of a small microphone or a small tubular attachment added to a conventional microphone.

10.370 Standard Microphone. A standard microphone is a microphone the response of which is accurately known for the condition under which it is to be used.

10.375 Thermophone. A thermophone is an electroacoustic transducer in which sound waves of calculable magnitude result from the expansion and contraction of the air adjacent to a conductor whose temperature varies in response to a current input.

NOTE: When used for the calibration of pressure microphones, a thermophone is generally used in a cavity the dimensions of which are small compared to a wavelength.

10.380 Vibration Meter (Vibrometer). A vibration meter is an apparatus for the measurement of displacement, velocity, or acceleration of a vibrating body.

10.385 Volume Indicator. A volume indicator is a standardized instrument having specified electrical and dynamic characteristics and read in a prescribed manner, for indicating the volume of a complex electric wave such as that corresponding to speech or music.

NOTE 1: The reading in vu is equal to the number of decibels above a reference level. The sensitivity is adjusted so that the reference level, or zero vu, is indicated when the instrument is connected across a 600-ohm resistor in which there is dissipated a power of 1 milliwatt at 1000 cycles per second.

NOTE 2: Specifications for a volume indicator are given in American Standard Volume Measurements of Electrical Speech and Program Waves, C16.5-1942, or the latest revision thereof approved by the American Standards Association, Incorporated.

SECTION 11

Shock and Vibration*

11.005 Steady-State Oscillation (Steady-State Vibration). Steady-state oscillation exists in a system if the velocity at each point is a periodic quantity.

NOTE: This is frequently a special case of forced oscillation. (See 2.130.)

11.010 Transient Motion. Transient motion is any motion which has not reached or has ceased to be a steady state.

11.015 Shock Motion. Shock motion, in a mechanical system, is transient motion which is characterized by suddenness and by significant relative displacements.

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*Many of the terms used in the field of shock and vibration are the same as those used in various branches of mechanics and acoustics. The following terms included in this standard are especially applicable to shock and vibration:

1.025	1.090	1.150	1.215	1.285	1.350	2.115	3.025
1.030	1.095	1.155	1.220	1.290	1.355	2.120	3.030
1.035	1.100	1.160	1.225	1.295	1.360	2.125	3.040
1.040	1.105	1.165	1.230	1.300	1.365	2.130	3.065
1.045	1.110	1.170	1.235	1.305	1.410	2.135	4.005
1.050	1.115	1.175	1.240	1.310	1.415	2.150	4.015
1.055	1.120	1.180	1.245	1.315	1.455	2.155	10.380
1.060	1.125	1.185	1.250	1.320	2.005	2.215	
1.070	1.130	1.190	1.255	1.325	2.060	2.280	
1.075	1.135	1.200	1.270	1.330	2.100	2.285	
1.080	1.140	1.205	1.275	1.340	2.105	3.010	
1.085	1.145	1.210	1.280	1.345	2.110	3.020	

11.020 Applied Shock. An applied shock is any excitation which, if applied to a system, would produce shock motion within the system.

SECTION 12

Acoustical Units

12.005 Acoustical Units. In acoustics, the centimeter-gram-second (cgs) system of units has been and is at present predominantly used; but some practical units such as English and Metric system units of length are also being used; and the watt is commonly being employed for designating acoustic power. In recent years there has been a trend toward adoption of the rationalized meter-kilogram-second system of units in many fields of science and engineering. It would, of course, be highly desirable if in place of the present diversity and mixture of scientific units, a single system of units could be universally used. While the mks units so far have not been employed in acoustics, if there is a trend toward their universal adoption, the workers in the field of acoustics will want to follow suit. For this reason, the Table 12.1 for the conversion of present acoustical units into mks units is being presented. (See page 41.)

Table 12.1

Conversion of Present Acoustical Units into Mks Units

Quantity	Dimension	Present Unit	Mks Unit	Conversion Factor*
Sound velocity (particle velocity)	LT^{-1}	cm per second	meter per second	10^{-2}
Volume velocity	L^3T^{-1}	cubic cm per second	cubic meter per second	10^{-6}
Sound energy	ML^2T^{-2}	erg	joule	10^{-7}
Force	MLT^{-2}	dyne	newton	10^{-5}
Sound pressure (sound-energy density)	$ML^{-1}T^{-2}$	microbar	newton per square meter	10^{-1}
Sound-energy flux (sound power of source)	ML^2T^{-3}	erg per second	watt	10^{-7}
Sound intensity (specific sound-energy flux)	MT^{-3}	erg per second per square cm watt per square cm	watt per square meter	10^{-3} 10^{4}
Acoustic impedance (resistance, reactance)	$ML^{-4}T^{-1}$	acoustical ohm	Mks acoustical ohm†	10^{5}
Specific acoustic impedance	$ML^{-2}T^{-1}$	acoustical ohm × square cm	Mks acoustical ohm† × square meter	10
Mechanical impedance (resistance, reactance)	MT^{-1}	mechanical ohm	Mks mechanical ohm†	10^{-3}

* Multiply the magnitude expressed in present units by the tabulated conversion factor to obtain magnitude in mks units.
† Mks acoustical ohm and mks mechanical ohm are proposed terms.

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